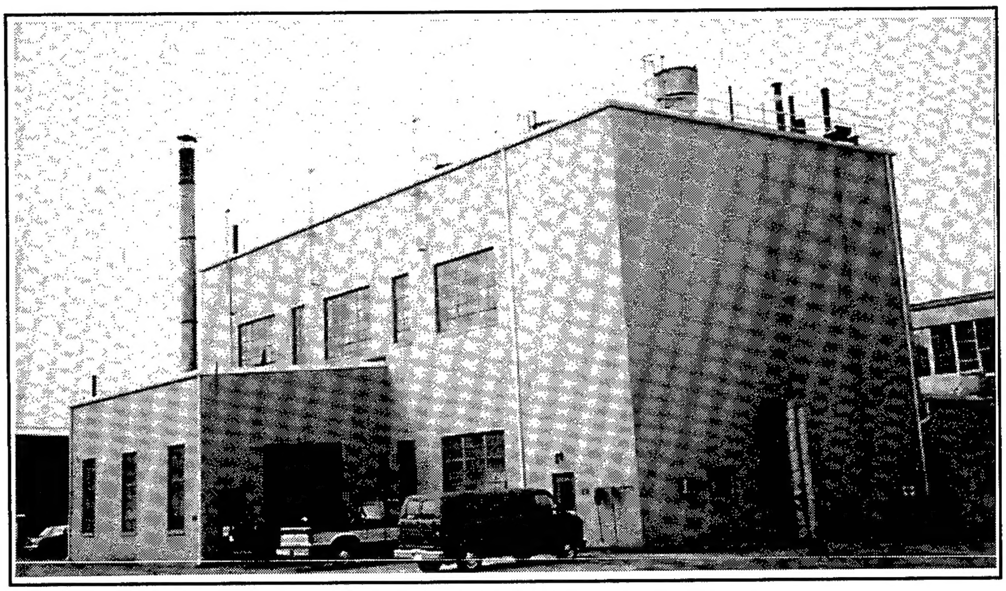
US Army Corps
of Engineers
Construction Engineering
Research Laboratories

USACERL Technical Report 96/86
August 1996

Central Heating Plant Modernization Study for Defense Distribution Region East

by
Martin J. Savoie
Thomas E. Durbin
Travis McCammon
Richard Carroll



Due to the age of its central heating plant (CHP) equipment and changes in energy industry environmental regulations, the Defense Distribution Region East (DDRE), New Cumberland, PA, began investigating modernization opportunities for its CHP. The U.S. Army Construction Engineering Research Laboratories (USACERL) was tasked with performing a central heating plant modernization study to determine viable options to provide energy for the coming years. Energy use patterns and the condition of existing equipment were determined, and five major potential energy supply alternatives were identified and evaluated on the basis of energy consumption and economics, including initial capital costs, annual fuel consumption, and annual Operations and Maintenance (O&M) costs.

For economy, it was recommended that boiler replacement be delayed until the year 2009, and that natural gas be used as fuel both before and after replacement, provided that funding for a natural gas pipeline can be obtained. If funding to replace the boilers does become available, the small difference in Life Cycle Cost should not delay DDRE from an immediate equipment upgrade.

USER EVALUATION OF REPORT

REFERENCE: USACERL Technical Report 96/86, *Central Heating Plant Modernization Study for Defense Distribution Region East*

Please take a few minutes to answer the questions below, tear out this sheet, and return it to USACERL. As user of this report, your customer comments will provide USACERL with information essential for improving future reports.

1. Does this report satisfy a need? (Comment on purpose, related project, or other area of interest for which report will be used.)

____

____

____

2. How, specifically, is the report being used? (Information source, design data or procedure, management procedure, source of ideas, etc.)

____

____

3. Has the information in this report led to any quantitative savings as far as manhours/contract dollars saved, operating costs avoided, efficiencies achieved, etc.? If so, please elaborate.

____

____

4. What is your evaluation of this report in the following areas?

a. Presentation: ______________________________

b. Completeness: ______________________________

c. Easy to Understand: ______________________________

d. Easy to Implement: ______________________________

e. Adequate Reference Material: ______________________________

f. Relates to Area of Interest: ______________________________

g. Did the report meet your expectations? ______________________________

h. Does the report raise unanswered questions? ______________________________

i. General Comments. (Indicate what you think should be changed to make this report and future reports of this type more responsive to your needs, more usable, improve readability, etc.)

____

____

____

____

____

____

5. If you would like to be contacted by the personnel who prepared this report to raise specific questions or discuss the topic, please fill in the following information.

Name: ______________________________

Telephone Number: ______________________________

Organization Address: ______________________________

____

____

6. Please mail the completed form to:

Department of the Army
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES
ATTN: CECER-TR-I
P.O. Box 9005
Champaign, IL 61826-9005

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*

2. REPORT DATE
August 1996

3. REPORT TYPE AND DATES COVERED
Final

4. TITLE AND SUBTITLE
Central Heating Plant Modernization Study for Defense Distribution Region East

5. FUNDING NUMBERS
MIPR RPM93-0085

6. AUTHOR(S)
Martin J. Savoie, Thomas E. Durbin, Travis McCammon, and Richard Carroll

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Construction Engineering Research Laboratories (USACERL)
P.O. Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
TR 96/86

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Defense Distribution Region East
ATTN: DLA-ASCE
14 Dedication Drive, Suite 3
New Cumberland, PA 17070-5011

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Due to the age of its central heating plant (CHP) equipment and changes in energy industry environmental regulations, the Defense Distribution Region East (DDRE), New Cumberland, PA, began investigating modernization opportunities for its CHP. The U.S. Army Construction Engineering Research Laboratories (USACERL) was tasked with performing a central heating plant modernization study to determine viable options to provide energy for the coming years. Energy use patterns and the condition of existing equipment were determined, and five major potential energy supply alternatives were identified and evaluated on the basis of energy consumption and economics, including initial capital costs, annual fuel consumption, and annual Operations and Maintenance (O&M) costs.

For economy, it was recommended that boiler replacement be delayed until the year 2009, and that natural gas be used as fuel both before and after replacement, provided that funding for a natural gas pipeline can be obtained. If funding to replace the boilers does become available, the small difference in Life Cycle Cost should not delay DDRE from an immediate equipment upgrade.

14. SUBJECT TERMS
central heating plants
energy conservation
equipment evaluation
life cycle costs

15. NUMBER OF PAGES
276

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

Foreword

This study was conducted for Defense Distribution Region East under Military Interdepartmental Purchase Request (MIPR) No. RPM93-0085; Work Unit 001CSM, "CHP Modernization for DDRE." The technical monitor was Peter Fludovich, DLA-ASCE.

The work was performed by the Utilities Division (UL-U) of the Utilities and Industrial Operations Laboratory (UL), U.S. Army Construction Engineering Research Laboratories (USACERL). Richard Carroll, of Stanley Consultants, performed technical and economic analysis of central heating plant alternatives. Boiler Inspection Services Company performed the Boiler Useful Life Study at DDRE. The USACERL principal investigator was Thomas E. Durbin. Martin J. Savoie is Chief, CECER-UL-U, and John T. Bandy is Operations Chief, CECER-UL. The USACERL technical editor was William J. Wolfe, Technical Resources Center.

COL James T. Scott is Commander of USACERL, and Dr. Michael J. O'Connor is Director.

Contents

List of Tables and Figures

Tables

Figures

1 Introduction

Background

The Defense Distribution Region East (DDRE), New Cumberland, PA serves as the regional headquarters for all defense depots east of the Mississippi River. DDRE is responsible for receiving, storing, issuing, and shipping commodities to all branches of the armed forces in the eastern United States, Europe, Central and South America, Iceland, Greenland, Newfoundland, the Middle East, and the Mediterranean Sea area. These commodities include medical material, construction supplies, electronics, clothing, and textiles.

DDRE has begun investigating modernization opportunities for its Central Heating Plant (CHP), which contains four boilers, three of which are 42 years old and one 17 years old. The age of this equipment warranted an investigation of alternatives for providing thermal energy for this facility. Increasing electrical costs have made cogeneration one potential alternative in modernizing the plant.

DDRE requested the U.S. Army Construction Engineering Research Laboratories (USACERL) to perform a study to determine the most viable options available to provide energy supply for the coming years.

Objective

The objective of this study is to identify the most cost-effective technologies for meeting current and future thermal and electrical energy needs at DDRE.

Approach

1. Information available from past studies and operating records were analyzed and verified to establish baseline conditions. A visual inspection of the CHP equipment was conducted to assess baseline operating conditions and problem areas.

2. Energy use patterns for DDRE were analyzed including current thermal and electrical energy demand, heating load, and usage patterns. Future energy use for the facility was projected using a variety of prediction methods depending on the energy type being investigated.

3. Potential thermal and electrical energy supply options were identified based on the energy use pattern analyses. These options were evaluated in terms of capital cost, operating cost, efficiency, reliability, and regionally available and appropriate fuel supplies.

4. Environmental factors, including demolition material disposal and air pollution control regulations, were reviewed and included in the cost analysis for each of the alternatives.

5. Life-cycle cost analyses were developed based on the study findings for maintaining the status quo, installing new boilers, cogeneration, and absorption chilling. The most cost effective alternative was developed into a more detailed conceptual study.

6. Conclusions were drawn, and specific recommendations were made for equipment upgrade and replacement, and continued monitoring.

Scope

The evaluation methods refined for the analysis and assessment of thermal and electrical requirements at DDRE will be useful to many other installations, particularly those with central heating plants.

Mode of Technology Transfer

It is recommended that the evaluation detailed in this report be incorporated into the planning and operation of the central heating plant at DDRE. It is anticipated that the evaluation methods used in producing this report will be incorporated into an Engineer Technical Letter (ETL) on evaluating central heating and power plants.

Analysis Software

This study used the following USACERL-developed analysis software:

Program	USACERL Report Reference
CHPECON	Lin, Mike. C.J., et al., *Central Heating Plant Evaluation Program*, FE-95/08, vol I-V (January 1995).
HEATLOAD	Currently unpublished software
REEP	Nemeth, Robert J., et. al., *Department of Defense (DOD) Renewables and Energy Efficiency Planning (REEP) Program Manual*, 95/20 (August 1995).
SHDP	Currently unpublished software
STATUS QUO	Savoie, Martin J., *The Central Heating Plant Status Quo Program*, FE-95/13 (March 1995)

Metric Conversion Table

The following conversion factors are provided for standard units of measure used throughout this report.

1 in.	=	25.4 mm
1 ft	=	0.305 m
1 sq ft	=	0.093 m^2
1 lb	=	0.453 kg
1 gal	=	3.78 L
1 psi	=	6.89 kPa
1 ft-lb	=	1.356 joules
1 ton	=	0.907 metric ton
1 ton (refrigeration)	=	3.516 kW
lb/sq ft	=	4.882 kg/m^2
°F	=	(°C × 1.8) + 32
1 Btu	=	1.055 kJ

2 Existing Steam Supply Systems

CHP

The DDRE CHP, Building 86, was constructed in 1952. Three 50,000 lb/hr coal-fired, field erected boilers were originally installed at the plant and produced 120 psig steam. These three boilers were converted to fire No. 6 oil in 1973, and two 300,000-gal oil storage tanks were installed. Table 1 lists design data for Boilers 1, 2, and 3. Boiler 4, an oil-fired, 20,000 lb/hr firetube boiler was installed in a building addition adjacent to the plant in 1977. Table 2 lists design data for Boiler 4. All four of the boilers are currently in operating condition.

Over the years, boiler tubes and refractory have been replaced as required; the burner controls for Boilers 1, 2, and 3 were replaced in 1977.

A portable flue gas analyzer was connected to three of the boilers in April 1994. Boiler 1 was not available for operation on the days testing was performed. The plant steam load limited the high load testing for the 50,000 lb/hr boilers. Boiler 3 was operated at loads up to 37,500 lb/hr and combustion efficiency ranged from 82.4 to 61 percent with stack temperature ranging from 544 to 421 °F. The combustibles in the flue gas increased as the boiler load was decreased. A boiler thermal efficiency for Boiler 3 was calculated to be 81 percent at 37,500 lb/hr and less than 60 percent at

Table 1. Design data for boilers 1, 2, and 3.

Category	Information
Manufacturer	Erie City
Year built	1952
Type	Traveling grate stoker fired, brick set watertube boiler with metal casing later converted to No. 6 fuel oil fired
Capacity	50,000 lbs/hr
Serial numbers	No. 1: 93148 No. 2: 93146 No. 3: 93147
National board numbers	No. 1: NB14061 No. 2: NB14059 No. 3: NB14060
Burner	Peabody Engineering, Model M, steam atomized, dual burners each boiler

Table 2. Design data for boiler 4.

Category	Information
Manufacturer	Trane
Year built	1977
Type	Firetube
Capacity	20,000 lbs/hr
Serial number	NB7751
Burner	Industrial combustion, model DE-252P

one-half load. Boiler 4 was tested at full load; the steam flow meter was not operational so the steam load was estimated. Stack temperature varied from 300 to 380 °F. Combustion efficiency varied from 68 to 53 percent with the low values attributable to the high percentage of combustibles in the flue gas. Thermal efficiency for Boiler 4 was calculated to vary from 52 to 67 percent for the stack temperatures and combustion efficiencies measured.

The CHP is generally in good condition. The equipment has been well maintained, but much of the equipment is approaching the end of its typical useful life. The asbestos piping insulation has been removed from the CHP. The asbestos removal completion is an important step because it eliminates a significant cost and reduces the time necessary to implement the CHP modernization plan.

Steam Distribution System

The CHP provides steam for heating and domestic hot water production through a system of below ground and overhead steam lines. The lines are run aboveground through buildings and underground outside of buildings. The steam is distributed at 120 psig to 38 buildings. Figure 1 shows the layout of the main distribution piping. The condensate return system parallels the steam system. Condensate is pumped back to the CHP. Steam system losses are indicated by the quantity of water added or made up to the system. The system makeup water replaces steam system live steam losses and condensate losses in places where the condensate is wasted. Figure 2 shows boiler water makeup for 1992. The system makeup follows steam load, as expected. The steam system is shut down in the summer months.

The makeup as a percentage of steam flow varies from 5 to 15 percent in the winter and from 15 to 30 percent in the spring and fall. The higher percentage of makeup in the spring and fall is due to the constant losses along the distribution system and the relatively lower quantity of steam produced. Condensate returns in excess of 80 percent for central systems of this type are not common and indicate a system that is in good condition and is being operated properly with all possible condensate being returned.

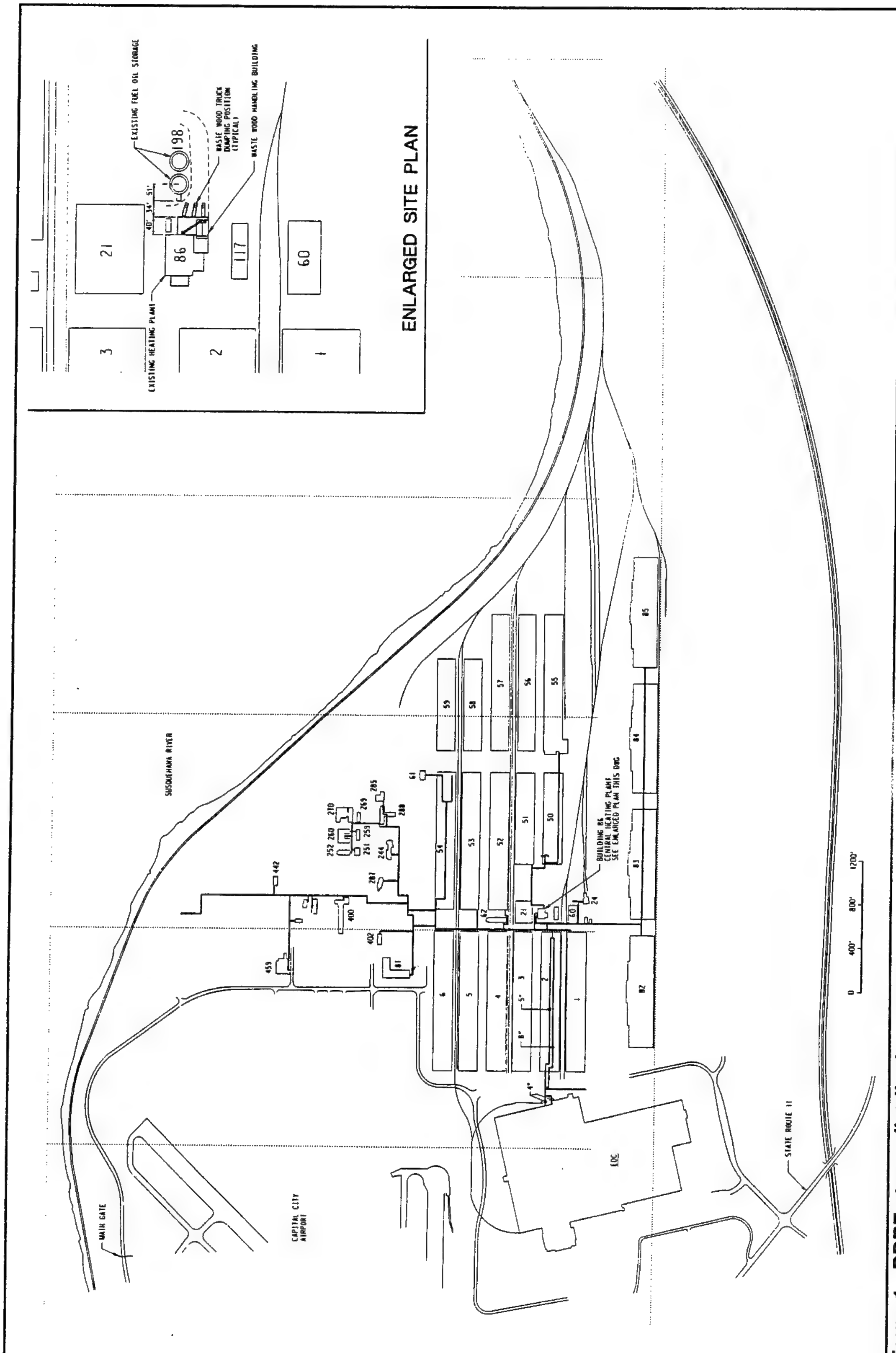


Figure 1. DDRE steam distribution system.

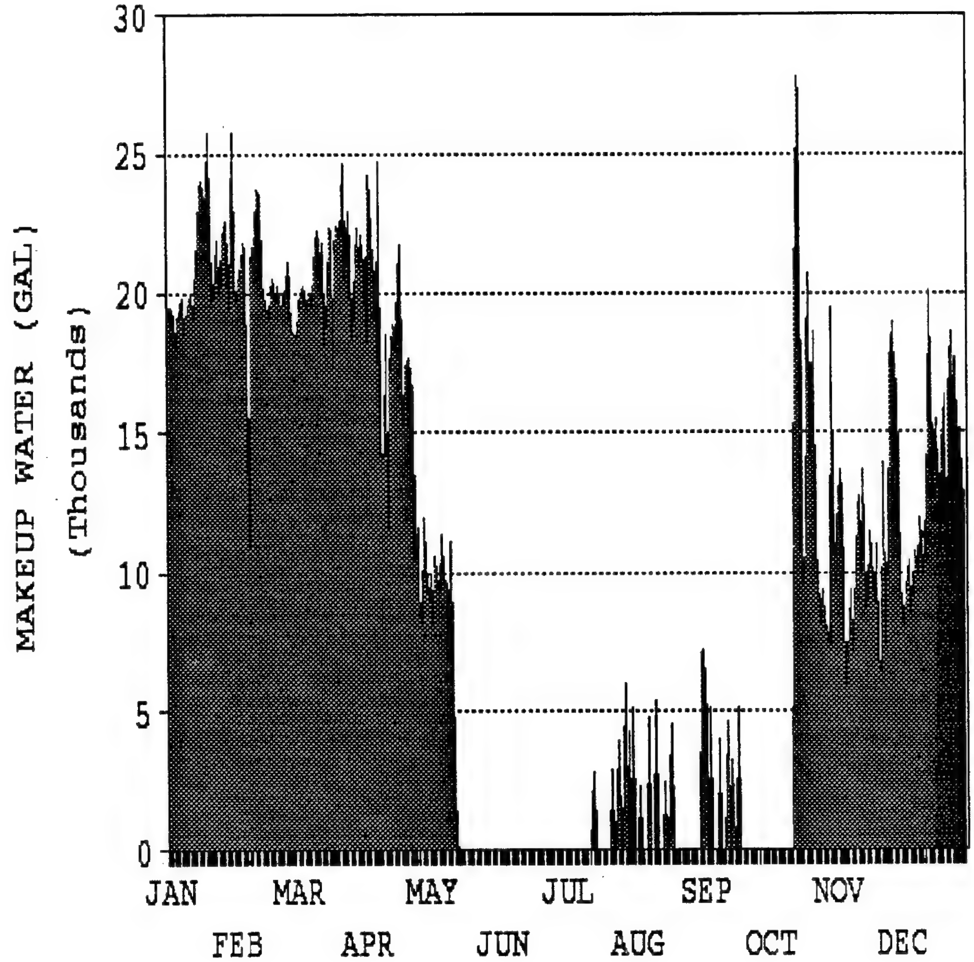


Figure 2. Daily boiler water makeup (1992).

3 Thermal Energy Supply and Consumption

The CHP steam output and fuel use were analyzed for trends and building heating loads and distribution systems losses were modeled. Correlations were developed between thermal energy use and heating degree days.

Cost of Steam

The cost of steam for the past year was developed by DDRE. Table 3 lists the costs included in the cost of steam produced at DDRE, which is relatively low. Typical steam costs for DOD facilities range from $6 to $10 per million Btu. The costs listed in Table 3 were based on purchasing No. 6 fuel oil for $0.61/gal. The price for No. 6 fuel oil for the next fiscal year will be $0.49/gal.

CHP Steam Load

The CHP steam load was taken from the 1992 boiler logs for each boiler. The boiler logs give the steam flow for each boiler, total steam produced, fuel oil used, and makeup water used. Figure 3 shows the steam load profile for 1992. The daily average steam load for the plant varied from a high of 88,400 lb/hr in January to low loads

Table 3. Cost of steam for DDRE (FY95).

Breakdown	Cost
In-house production cost (includes labor and fuel cost)	$ 1,626,012.00
Normal maintenance (planned maintenance)	$ 20,354.00
Abnormal maintenance (amortized cost of major maintenance	$ 53,722.00
Total	$ 1,700,088.00
Total steam consumption (lb)	$ 277,406,897.00
Cost per million Btu (annual costs)	$ 6.13
Cost of capital (annual charge)	$ 66,410.00
Annual system capacity (lb)	$ 1,489,200,000.00
Unit cost of capital (per million Btu)	$ 0.045
Total cost per million Btu (annual and capital cost)	$ 6.18

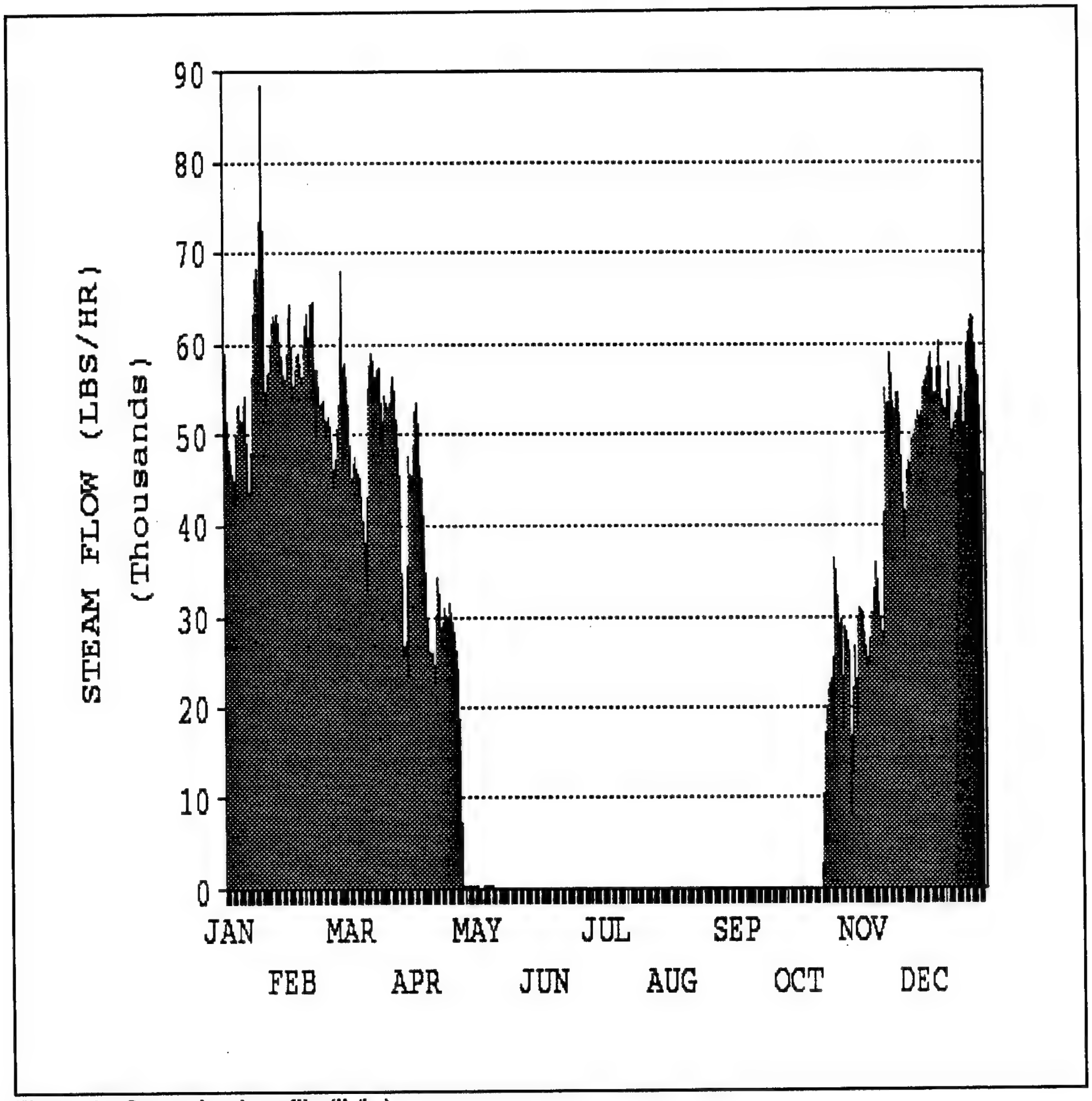


Figure 3. Steam load profile (lb/hr).

of approximately 20,000 lb/hr in April and October at the end and beginning of the heating season. The plant is shut down in April and restarted in October when building heating is required. The boiler in the EDC is operated during the summer months to supply hot water.

Figure 4 shows the plant energy output in million Btuh. Figure 4 shows information similar to that in Figure 5 except the output is expressed in million Btuh instead of steam lb/hr. The total heat of the steam is used, not just the heat of vaporization.

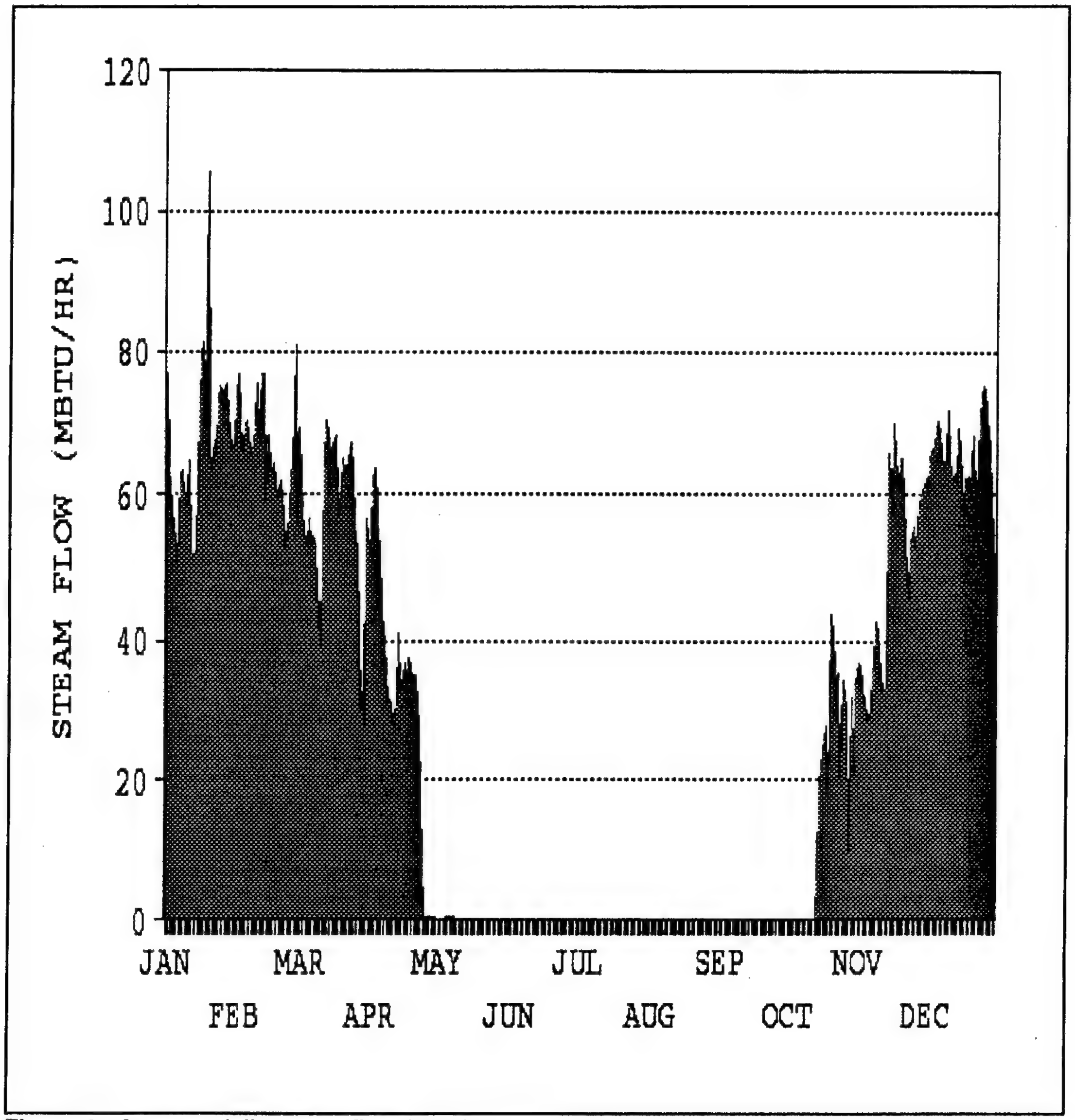


Figure 4. Average daily steam flow (1992).

Steam End Use

While the CHP output is a good indicator of current thermal energy use, individual building loads were also estimated to determine the efficiency of the existing distribution system. There are currently no operating steam meters to measure individual building heating or process loads. End user loads were estimated using modeling techniques. The modeling technique used to estimate the end user load was HEATLOAD, a USACERL-developed program that provides a simple method of calculating building heat requirements. Other computer programs such as BLAST or DOE2 can provide more accurate analysis, but require much more information to develop a heat load

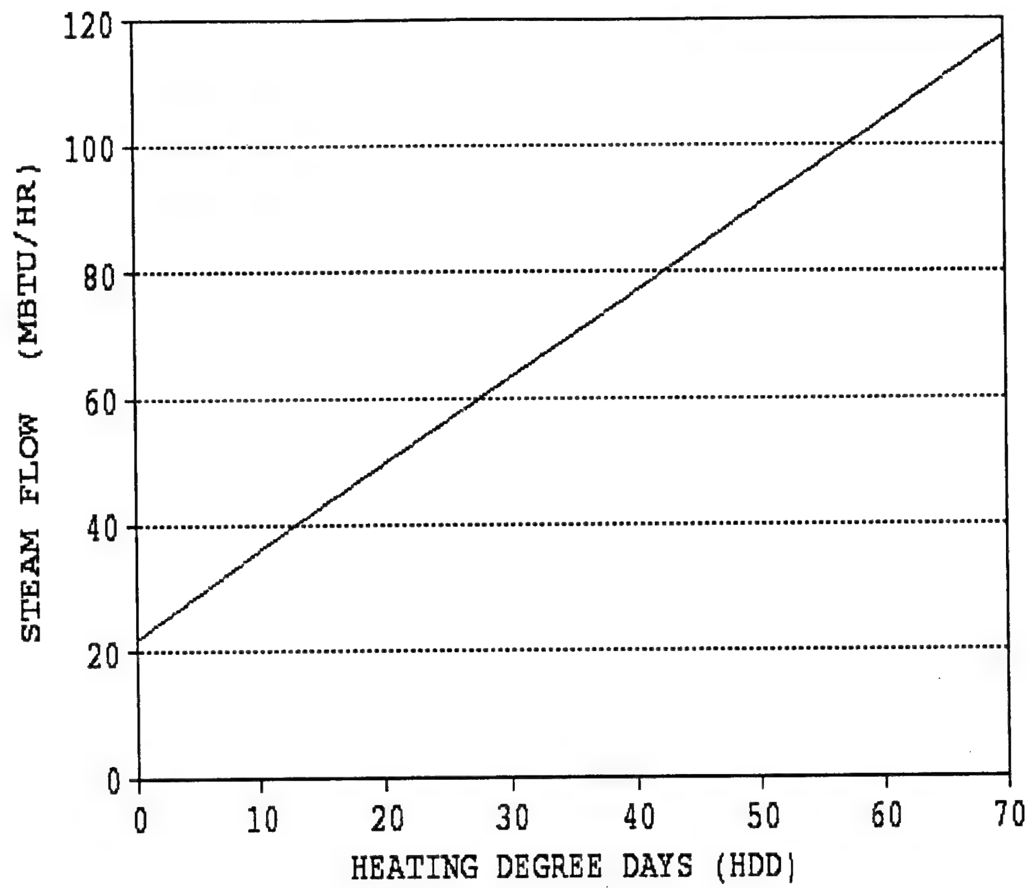


Figure 5. Steam flow regression.

estimate. Experience with HEATLOAD has shown it to be an accurate for estimating installation-wide building heat requirements for CEP alternatives.

HEATLOAD is based on a series of linear regressions developed from heating use measurements at typical facilities on several Army installations. Facility categories and corresponding daily heating energy consumption are factored into the equation:

$$E_h = a_1 + (b_1 \times HDD_d) \quad \text{[Eq 1]}$$

where:

E_h = the daily heating degree

a_1 = a regression parameter; a constant that represents energy usage that occurs for zero HDD and reflects nonheating loads such as hot water and cooking

b_1 = regression parameter; the heating load parameter.

Table 4. Building categories and energy consumption.

Category	Formula
Administration/training	$E_h = 75.71 + (7.02 \times HDD_d)$
Storage	$E_h = 35.70 + (10.53 \times HDD_d)$
Production/maintenance	$E_h = 138.25 + (10.53 \times HDD_d)$
Fieldhouse/gymnasiums	$E_h = 73.69 + (4.39 \times HDD_d)$

Building categories and area (sq ft) are obtained from the master planning files. Table 4 lists the parameters used for buildings at DDRE.

The climatological data required for HEATLOAD such as the historical average HDD and the design temperature, are obtained from the Army Technical Manual (TM) 5.785, *Engineering Weather Data* (1978) or directly from the USAF Environmental Technical Applications Center (ETAC) at Scott AFB, IL. With this information, HEATLOAD will calculate the peak hourly heating load, average monthly loads, maximum monthly loads, and total annual heating load. Table 5 shows the total monthly building heat loads estimated from steam consumption data. Individual building load estimates were based on 1992 heating degree days and summed for each month. Table 6 lists building estimated heating loads for individual DDRE buildings.

A steam distribution system typically consists of steam generators, piping, regulators, valves, and steam traps. Steam enters the system at the steam plant, passes through the piping and valves, and is delivered to the buildings. The steam loses heat through the piping walls by conduction. As the steam passes through the piping and valves, the pressure decreases due to the friction of the steam with the pipe wall and fittings. Condensate forms in the piping as the steam condenses and is removed through the steam traps. The quantity of energy lost through the steam distribution system can be substantial. This study used a computer model—the "Steam Heat Distribution Program" (SHDP)—to analyze the distribution system losses.

Table 5. Estimated monthly building heating loads.

Month	Heatload (Million Btu)
Jan	49,626
Feb	46,127
Mar	41,589
Apr	21,236
May	60
Jun	11
Jul	12
Aug	12
Sep	14
Oct	11,368
Nov	34,917
Dec	48,338

Steam Heat Distribution Program Analysis

SHDP is a pressure-flow-thermal efficiency computer program for modeling steam district heating systems. The program has several capabilities including the design and economic evaluation of manhole renovation and modifications to existing distribution systems. It also has the capability to perform economic evaluation of operating a system at a lower pressure and improving system performance by improving the steam trap maintenance. In this study, SHDP was used primarily to estimate distribution system losses. To use SHDP, the entire DDRE steam distribu-

Table 6. Estimated building heating loads.

Building Number	Square Footage	Yearly Heat Load (Million Btu)	Average Heat Load (Million Btu/hr)
1	225,200	15,054	5.28
2	203,021	13,572	4.76
5	203,021	13,572	4.76
6	203,021	13,572	4.76
24	3,098	323	0.09
50	135,401	9,051	3.17
51	135,401	9,051	3.17
52	203,021	13,572	4.76
53	203,021	13,572	4.76
54	215,318	14,394	5.04
55	215,318	14,394	5.04
60	12,768	854	0.30
61	3,136	210	0.07
62	3,322	222	0.08
**	3,322	293	0.03
64	1,500	95	0.03
68	1,400	89	0.02
81	59,528	3,781	1.06
**	3,898	344	0.04
82	200,000	13,370	4.69
83	200,000	13,370	4.69
84	271,932	18,178	6.37
85	208,536	13,943	4.89
244	5,345	339	0.10
251	2,220	232	0.06
252	3,933	438	0.08
259	2,477	157	0.04
260	9,970	633	0.18
268	14,740	936	0.26
269	2,284	145	0.04
270	12,988	1,446	0.27
285	2,284	145	0.04
287	3,728	415	0.08
400	6,392	406	0.11
	27,912	2,832	0.76
	4,944	437	0.05
402	2,351	140	0.04
406	1,800	120	0.04
411	2,140	192	0.04
412	6,100	679	0.13
442	3,030	337	0.06
459	11,833	586	0.15

tion system was mapped. (Refer to Figure 1 for a map of the steam distribution system with the general location of the major buildings.)

SHDP is designed to estimate the total heat load for the CHP with a breakdown of the distributions system losses. This requires entering the distribution system pipe diameters and lengths, CHP supply pressure, and individual building loads. Pipe diameters

and lengths were obtained from drawings of the distribution system. The thermal loads for each building were estimated using the HEATLOAD program. Table 7 lists the basic assumptions that were made in creating the distribution system model for DDRE.

SHDP calculates that, for a design day of 5 °F, the total steam to all loads will be 77,800 lb/hr and that the total plant output will be 87,300 lb/hr. The distribution system heat loss will condense 9,500 lb/hr of steam.

Heating Load vs. Heating Degree Day (HDD) Model

Heating loads are typically very closely related to the outside temperature. A single year is not always a good prediction of the steam demand for the 25-year period required for life-cycle cost analysis of alternatives unless it is very close to the normal year. A correlation developed between steam demand and HDD for 1 year can be used to project the steam demand for the life of the study period. Linear regressions were performed on the load profiles and the corresponding HDD. The monthly HDD for study period were obtained for 37 years from ETAC (Table 8).

Figure 5 shows the results of the linear regression of steam production and heating degree days. The steam flow is expressed in million Btu. This includes the total heat in the steam plant output, not just the heat of vaporization.

Table 7. SHDP model assumptions.

Category	Assumed Value
Pipe environment temperature	45 °F
Condensate return temperature	150 °F
Steam trap leakage rate	0%
Fraction of load condensate returned	100%*
Fraction of pipe condensate returned	100%*
* Makeup to the system was calculated separately outside the program.	

Table 8. Average monthly heating degree days.

Month	HDD
Jan	1035
Feb	871
Mar	695
Apr	367
May	126
Jun	16
Jul	1
Aug	4
Sep	62
Oct	283
Nov	567
Dec	932

4 Electrical Power Consumption

This Chapter describes the current electrical energy supply and use. Trends in electrical power supplied by the utility were analyzed and the cooling load served by chillers in the Eastern Distribution Center was modeled.

Electrical Costs

The Pennsylvania Power and Light Company supplies electric power for the DDRE facility. The electricity cost is based on their Rate Schedule LP-5, Large General Service at 69,000 volts or higher (Table 9). The billing kW is the average number of kW supplied during the 15-minute period of maximum use during the current billing period. Just before completion of this report, a new electric rate schedule was implemented. Appendix A includes a comparison of the new and old rates. Figure 6 shows how the components of the electric rate contribute to the total cost for electricity at the facility, in which:

- The kW demand charge is the $4.39 per kW on the rate schedule.
- KW rate 1 is the $0.0486 per kWh for the first 150 kWh per kW of the billing kW but not more than 1,200,000 kWh.
- KW rate 2 is the $0.0443 per kWh for the next 100 kWh per kW of the billing kW.
- KW rate 3 is the $0.0368 per kWh for the next 150 kWh per kW of the billing kW.
- KW rate 4 is the $0.0321 per kWh for all additional kWh.
- The energy charge category shown is the $0.009622 per kWh minus the Special Base Rate Credit Adjustment of -2.30 percent.

Table 9. Electric rate schedule.

Demand charge:	$4.39 per kilowatt (kW) for all kW of the billing kW
	$0.0486 per kWh for the first 150 kWh per kW of the billing kW, but not more than 1,200,000 kWh
	$0.0443 per kWh for the next 100 kWh per kW of the billing kW
	$0.0368 per kWh for the next 150 kWh per kW of the billing kW
	$0.0321 per kWh for all additional kWh
Energy charge:	$0.009622 per kWh
Special base rate credit adjustment:	-2.30 percent

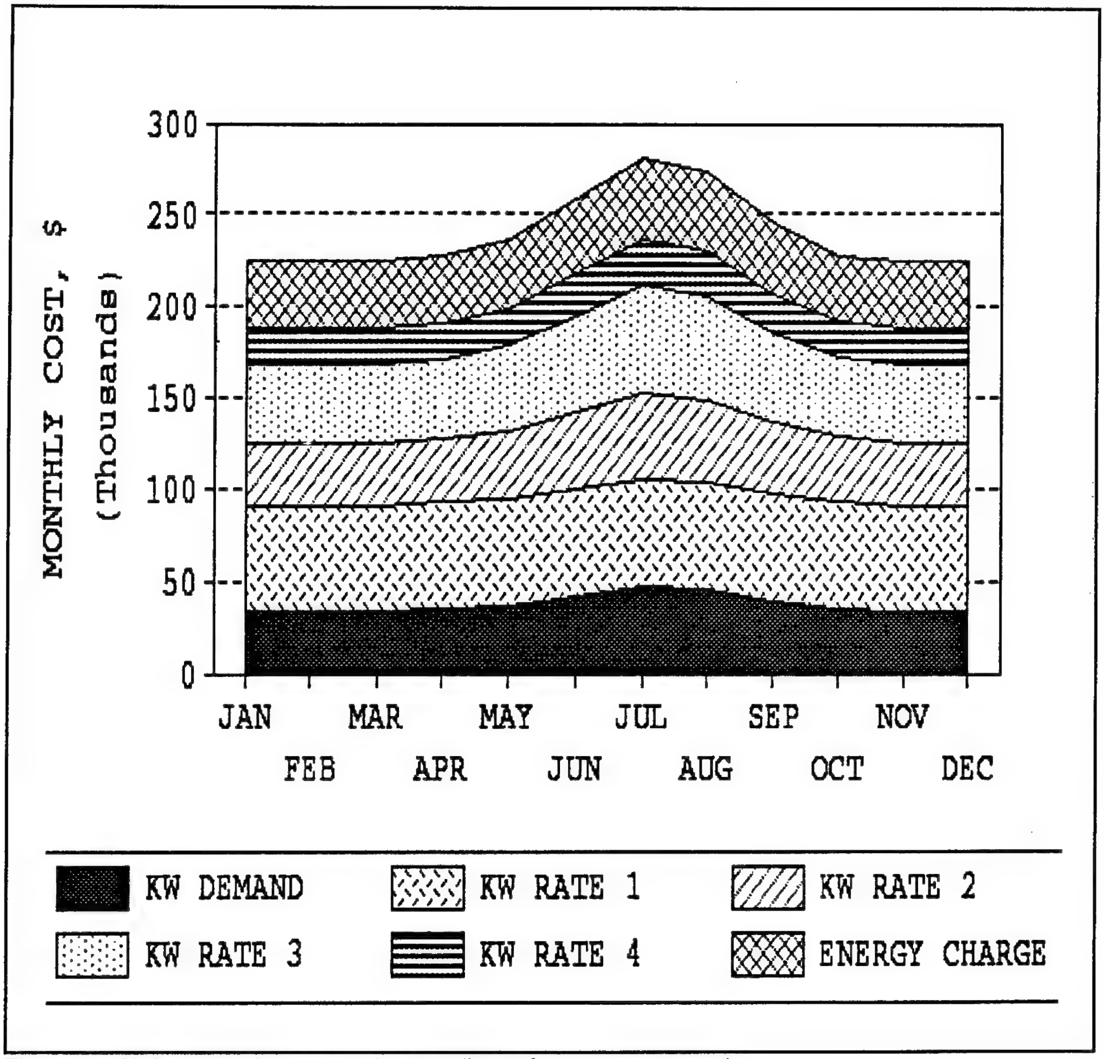


Figure 6. Major electric power charges (based on current rates).

The total cost of electricity for FY 93 was $2.738 million for 46.97 million kWh for an average cost of $0.0583 per kWh, which equals $17.08 per million Btu.

Purchased Electricity

Electricity use at DDRE peaks during the mid-part of the business day and weekend day. Figure 7 shows the daily electrical load profile for some typical summer and winter work days and weekend days. The lines labeled SWKDAY and SWKEND are summer work days and summer weekend days, respectively. The lines labeled WWKDAY and WWKEND are winter work days and winter weekend days, respectively. Figure 8 shows some typical load profiles for 1-week periods in different months of the year. The load peaks are higher in the summer than the winter. Figure 9 shows the load profile for 1992. The peak load in the summer approaches 10,000 kW and the minimum load over the course of the year is approximately 3,000 kW.

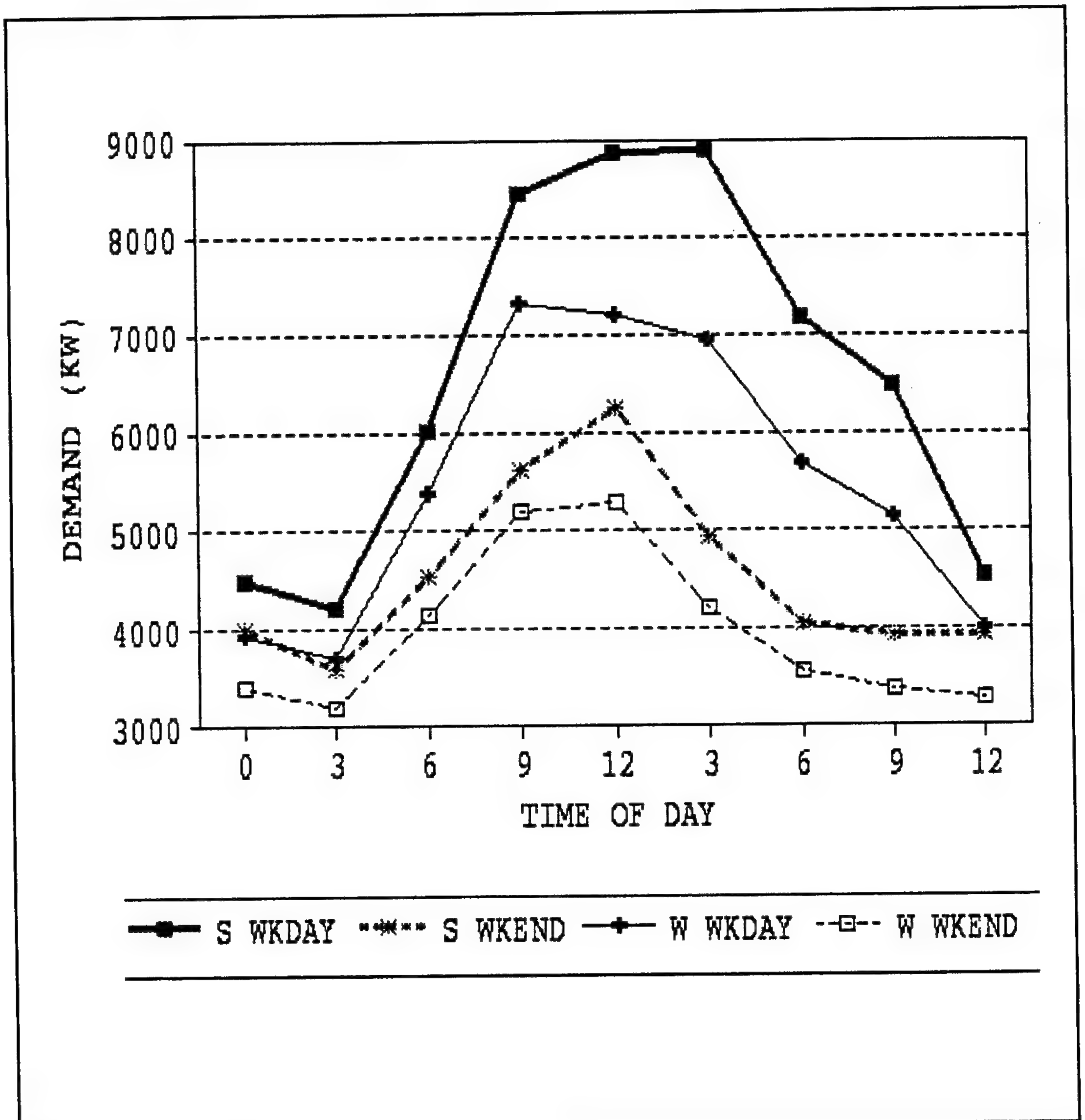


Figure 7. Typical daily load profiles.

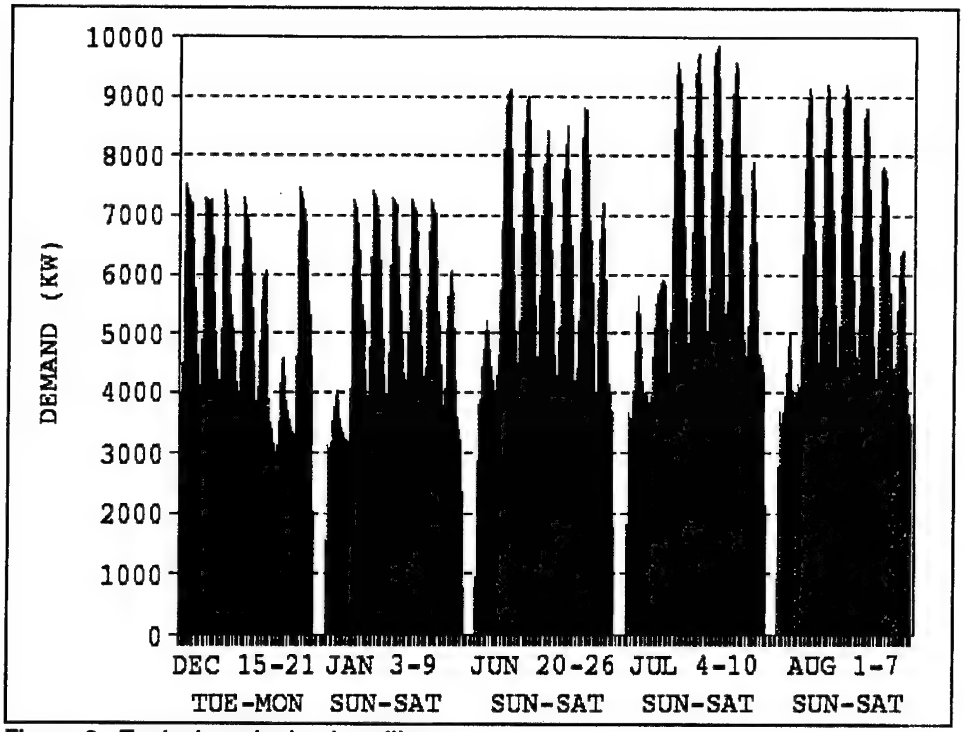


Figure 8. Typical weekly load profiles.

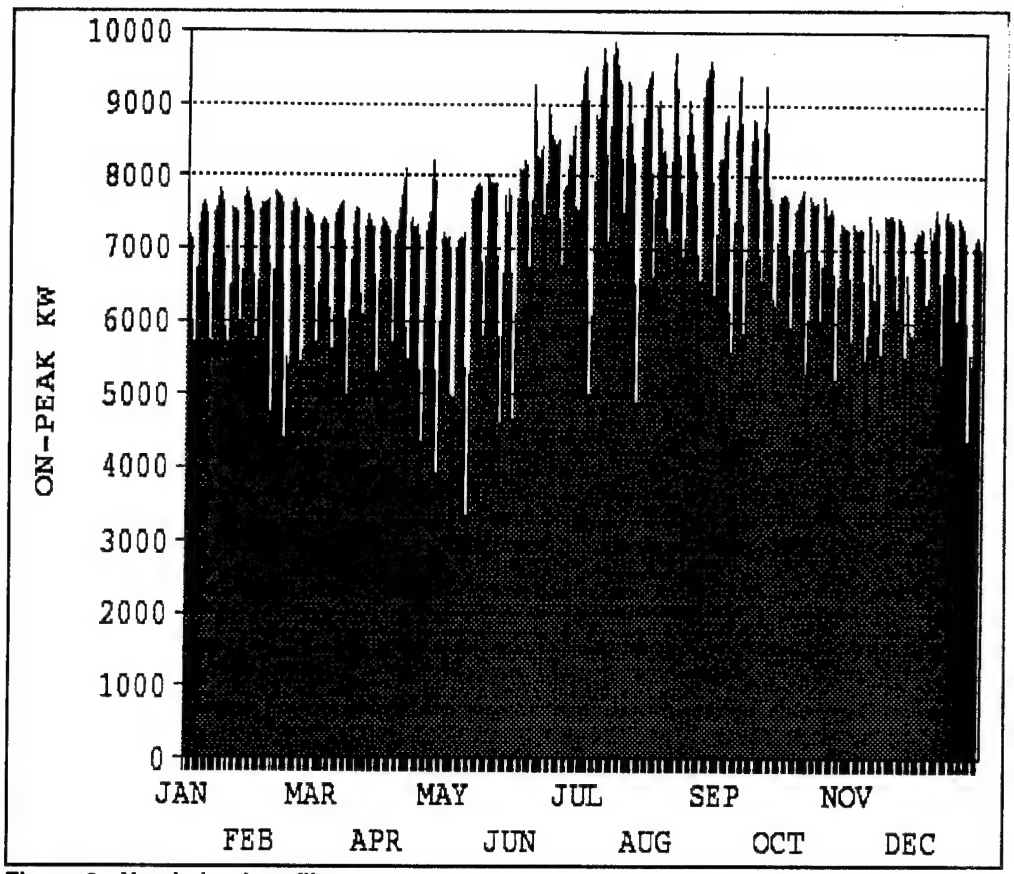


Figure 9. Yearly load profiles.

5 Projected Energy Consumption

DDRE is not planning any large scale increase in the facility buildings that would have a significant impact on the CHP or electrical power use. Table 10 lists the currently planned projects that will increase the area served by the CHP.

The current building plan will increase the total area served by the CHP less than 5 percent, i.e., the plant peak load will not increase greatly. The existing plant average daily peak for 1992 was 88,000 lb/hr. The average daily plant peak calculated for the design heating degree day of 60 is 87,500 lb/hr. The plant firm peak design capacity was then set at 95,000 lb/hr to meet the expected load growth over the study period. The plant firm capacity is the plant output with the largest boiler out of service. This way, the plant could then meet the peak load if the largest boiler were down for maintenance or had some component failure that forced it off line.

The total annual steam production at the plant could be increased by installing an absorption chiller to replace one of the electrically powered centrifugal chiller at the EDC. This scenario would increase the steam use in the summer during the air-conditioning season, but would not affect the winter peak load, when the plant peak occurs. The plant firm capacity would not change with the installation of the absorption chiller. Figure 10 shows the steam load profile with a 900-ton absorption chiller installed on the steam distribution system. The profile presented is based on 1992 and 1993 steam and chilled water use data. This scheme provides up to approximately 11,000 lb/hr of steam load in the summer months, where there is no steam load with the current facility operation as shown on Figure 10. Table 11 shows the Normal HDD, monthly heating load estimates with and without an absorption chiller, and the 1992 heating loads.

Figure 11 shows the electrical power consumption for 1992, and for a "normal" year. The consumption in the normal year was developed by taking the usage in 1992 and adjusting it to match the average cooling degree day year. The consumption for a normal year peaks slightly higher than

Table 10. Building and building expansion planned (increases in spaces heated by CHP only).

Building	Heated Square Footage	Year Complete
Hazardous material storage	78,000	1995
Bulk storage	800	1997
EDC addition	73,000	1998

the 1992 year, but is not higher in all months. Table 12 tabulates the 1992 electrical use compared to the predicted usage for a normal year with and without the installation of an absorption chiller. The absorption chiller replaces the electrical load of the existing centrifugal chiller with steam load.

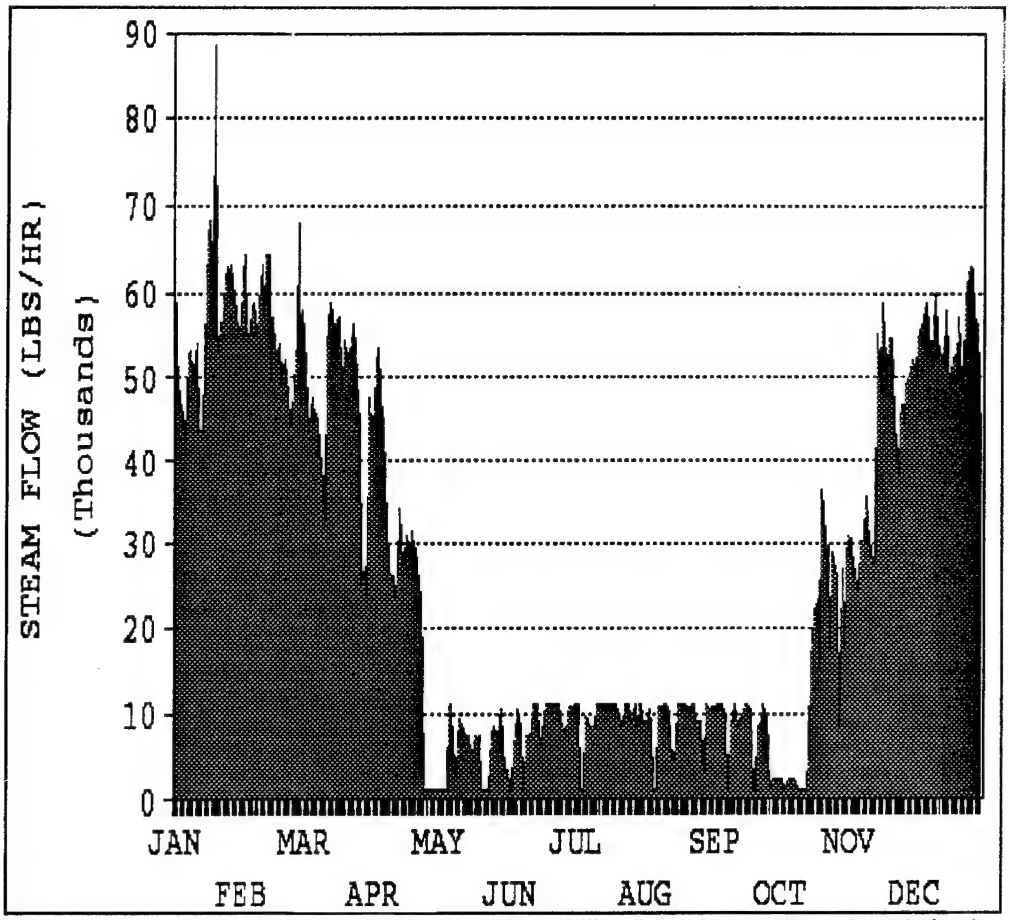


Figure 10. Average steam flow with absorption chiller (based on 1992 and 1993 data).

Table 11. CHP heating loads.

Month	Normal HDD	Estimated Normal Steam Load (lb) W/ Chiller	W/O Chiller	1992 Steam Load (lb)	1992 HDD
Jan	1,035	45,500,000	45,500,000	41,619,000	947
Feb	871	40,900,000	40,900,000	38,685,000	824
Mar	695	32,600,000	32,600,000	34,878,000	743
Apr	367	17,400,000	17,400,000	17,772,000	374
May	126	3,800,000	0	51,000	146
Jun	16	5,600,000	0	0	11
Jul	1	6,700,000	0	0	1
Aug	4	6,200,000	0	0	3
Sep	62	5,100,000	0	0	72
Oct	283	9,800,000	7,400,000	9,749,000	373
Nov	567	27,200,000	27,200,000	29,283,000	613
Dec	932	41,500,000	41,500,000	40,539,000	912
Total	**4,959**	**242,300,000**	**212,500,000**	**212,576,000**	**5,019**

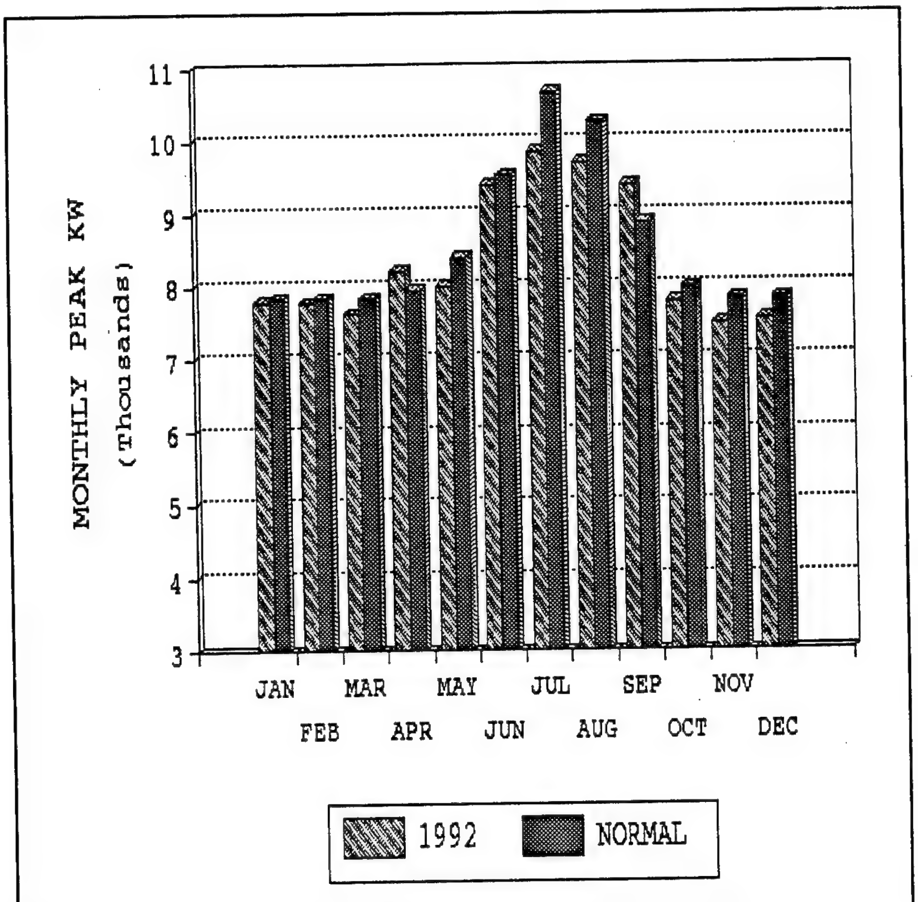


Figure 11. Electrical power consumption.

Table 12. DDRE electrical loads.

Estimated normal electrical load (kWh)				
Month	Normal CDD	W/ Chiller	W/O Chiller	1992 Electrical Load – kWh
Jan	0	3,763,000	3,762,000	4,004,400
Feb	0	3,762,000	3,762,000	3,697,200
Mar	1	3,765,000	3,765,000	3,688,800
Apr	17	3,807,000	3,807,000	3,693,600
May	69	3,911,000	3,948,000	3,422,400
Jun	210	4,015,000	4,327,000	3,871,200
Jul	315	4,284,000	4,700,000	4,488,000
Aug	297	4,222,000	4,562,000	4,515,600
Sep	130	3,833,000	4,112,000	4,512,300
Oct	19	3,815,000	3,815,000	3,890,400
Nov	2	3,767,000	3,767,000	3,750,000
Dec	0	3,762,000	3,762,000	3,829,200

6 Air Quality Regulations

Air quality regulations have a significant impact on the changes that can be made at the CHP. Changes that increase emissions must follow certain rules that can make the cost of some options prohibitive.

DDRE is located in Fairview Township of York County, PA, which falls within U.S. Environmental Protection Agency (USEPA) Region III. The state air pollution control authority for DDRE is the Pennsylvania DER, located in Harrisburg, PA. DDRE has no air quality compliance problems with the existing CHP. The boilers are registered with the DER and only Boiler 4 has (and is required to have) a permit.

Federal Regulatory Requirements

The USEPA has divided the United States into geographic regions to evaluate compliance with the National Ambient Air Quality Standards (NAAQS). DDRE is located in the York County portion of the South Central Pennsylvania Intrastate Air Quality Control Region. This part of the county has received the Designation Type of Nonattainment and the Classification Type of Marginal for ozone, and has been listed as "Better than the National Standards" for total suspended particulate (TSP) and sulfur dioxide (SO_2) and also as "Cannot be Classified or Better than the National Standards" for nitrogen oxides (NOx). The area is listed as an "Unclassifiable/Attainment Designation Type" for carbon monoxide (CO). The area is not listed in the initial "Nonattainment Areas" for particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{10}).

New emission sources or major modifications to existing major emission sources are limited in the increased quantity of certain emissions that can be generated. Precursors to ozone are volatile organic compounds (VOC) and NOx, which are among the emissions that are limited. Table 13 lists the thresholds of the increases in emissions that must be met to avoid Prevention of Significant Deterioration (PSD) and Best Available Control Technology (BACT) regulations.

The entire state of Pennsylvania is in the Northeast Ozone Transport Region. In this Ozone Transport Region, the sum of the increased NOx and VOC emissions must be less than 50 tons per year, or the Lowest Achievable Emission Rate equipment must be installed, and emission offsets may be required. Chapter 7 lists the emissions calculated for the alternate schemes studied. Emission factors used in the calculations were taken from USEPA Publication AP-42 and vendor-predicted data.

Table 13. Thresholds of increases in emissions that must be met to avoid PSD and BACT regulation violations.

Emission	Threshold
Volatile Organic Compounds	40 tons per year
Total Suspended Particulate	15 tons per year
Sulfur Dioxide	40 tons per year
Nitrogen Oxides	40 tons per year
Carbon Monoxide	100 tons per year
PM_{10}	15 tons per year
Lead	0.70 tons per year

State and Local Regulatory Requirements

The State regulations limit the particulate emissions for the waste wood fired boiler in Alternative Four to 0.10 grains per dry standard cubic foot. This is equivalent to 0.133 lb of particulate per million Btu of fuel input to the incinerator.

7 Study Alternatives

Four alternatives, one with a second option, were evaluated and compared to a status quo option, which was developed as a baseline for comparison. Life-cycle cost (LCC) analyses were performed on all alternatives and on the status quo using the life-cycle cost in design (LCCID) program.

Status Quo Alternative

The status quo or baseline alternative was developed using the STATUS QUO model developed by USACERL to provide a microcomputer-based technique to establish the existing condition of a CHP. The program was funded by the DOD Coal Use Program. The "status quo" situation implies the continued operation of the plant by performing routine maintenance and repair along with replacement of the various pieces of equipment on a scheduled basis. The STATUS QUO model provides a baseline alternative with which to compare the other plant alternatives.

The evaluation of the status quo of the CHP is determined through a field survey of the plant equipment. Evaluation forms are completed for all major components in the plant. The model is capable of estimating the life expectancy and cost of boiler equipment in the 20 to 200 million Btu/hr range. The model input consists of equipment size, capacity, performance data, general condition, and year of installation. The STATUS QUO program will display the year the equipment should be replaced and the equipment cost in terms of study year dollars. Costs are based on average industry prices; the replacement year is based on industry experience.

The program allows the default values to be changed if better information is available. For instance, a good method for establishing watertube boiler life is by measuring the steam drum metal thickness and comparing it to the original thickness and pressure rating. Boiler codes limit allowable pressures based on the drum metal thickness. Other components have methods available to determine the condition of the component and life expectancy. Vibration analysis, motor testing, ultrasonic testing, thickness testing, oil analysis, infrared thermal surveys, eddy current testing, equipment performance tracking, and equipment run time can all be used as an indication of the current condition of equipment, which can help predict a remaining useful life.

The program contains default values for labor, maintenance, spare parts, and utility costs. The actual plant operating costs should be used if they are available. The STATUS QUO model uses the LCCID program to perform the LCC analysis. The STATUS QUO program produces an LCCID input file containing all the plant components with their replacement cost, year the equipment will be replaced, along with labor, maintenance, spare part, and utility costs.

This alternative assumed the three existing 50,000 lb/hr boilers would be replaced in the year 2004. Replacement burners would be included with the replacement boilers. Current air quality regulations limit the modification of an existing boiler to 50 percent of the cost of a new boiler installation without being classified as a "major modification." Replacement boilers or boilers that had been through a "major modification," would not be allowed to burn any oil containing more than 0.5 percent sulfur. This requirement basically eliminates No. 6 oil as a fuel for replacement boilers since it normally contains more sulfur than this. No. 6 oil can be cleaned to remove some of the sulfur, but this drives the cost of the oil up to near No. 2 oil prices. This alternative assumes that the boilers could be replaced and could then use No. 2 oil for fuel. The status quo calculations were split into two periods, A and B, to allow the change in fuel type, price, and boiler efficiency.

Table 14 shows the LCC summary for this alternative. Costs shown are the 1994 net present worth of the LCC of the plant based on a 25-year life. The electric cost shown is for the entire DDRE facility. This total cost is used to show the difference in electrical costs when cogeneration is studied in Alternatives 2 and 3. The cost for the No. 6 oil is based on the predicted cost of $0.49 /gal or $3.32 per million Btu. The "Normal" fuel oil consumption was at the current boiler efficiency for Period A and the quantity was adjusted to account for the improved combustion efficiency of the new boilers and burners installed in Period B.

The maintenance labor and supply costs are taken from the plant records. The service cost listed is for disposal of wood waste for the DDRE. Alternative 4 considers a waste wood boiler installation so the costs for disposal are added to all the cases to set the

Table 14. Status Quo alternative LCC summary.

Initial Investment Cost		**0**
Energy costs:		
Electricity	$ 38,556,000.00	
Fuel oil	$ 20,258,000.00	
Total energy cost		$ 58,814,000.00
Recurring maintenance, repair, and custodial costs		$ 34,193,000.00
Major repair and replacement costs		$ 4,361,000.00
Net present worth of the LCCs and benefits		$ 97,368,000.00

cases equal when the lower cost is used in any particular case. The discount rate used in the LCC analyses is 4.7 percent. The escalation rate for electricity is 0.57 percent, and 2.96 percent for No. 6 oil. A copy of the computer program output can be found in Appendix B.

General Improvements and Upkeep

All alternatives studied include replacement of the existing plant equipment. The equipment listed in Table 15 would be replaced in all of the alternatives when it reaches the end of its useful life. The table does not list equipment that will be installed only for a specific alternative. The earliest equipment replacement listed is 1997 because that is planned for the midpoint of construction for any construction project.

Natural Gas Supply Options

The DDRE facility is currently corresponding with the local gas company in an attempt to have natural gas supplied to the facility. Natural gas is not currently piped to DDRE. The gas supplier has proposed the following two schemes for the gas supply:

1. A gas supply line that could supply natural gas in a quantity to match the existing fuel use could be installed to serve the facility. The cost of this line was estimated to be $1.1 million in 1989 dollars.
2. A gas supply line could be installed to serve the existing load plus a cogeneration system for $4 million in 1989 dollars. This line would apparently have to be routed from a source farther from DDRE than the proposed line that would serve only the existing load.

Table 15. Equipment replacement common to all alternatives.

Equipment	Year Replaced
Boiler feed pumps	1997
Deaerator	1997
Feedwater heater	2018
Treated water pumps	1997
Treated water storage tank repair	1997
Condensate pumps and receiver	1997
General piping and valve replacement	1997
Fuel oil pumps	1997
Fuel oil tanks	2012
Air compressor and receiver	2009
Emergency generator	1997
Sump pump	1997
Electrical switchgear and motor control centers	1997
Building lights, windows, doors, etc.	1997

The cost for the natural gas would be based on the price of the fuel DDRE is currently using. If gas were replacing No. 6 fuel oil, it would be priced the same as that fuel and the cost would be the same as No. 2 fuel oil

if it were replacing No. 2 fuel oil firing. The rate for natural gas with No. 6 fuel oil as its alternative would be \$3.32, and the rate for natural gas with No. 2 fuel oil as its alternative would be \$4.32. These rates are both based on an interruptible gas supply.

Alternative 1—New Gas/Oil Boilers

Alternative 1 replaces the existing boilers with new gas/oil boilers. The three 50,000 lb/hr boilers would be replaced by two packaged 75,000 lb/hr boilers. The 20,000 lb/hr firetube boiler would be replaced with a firetube boiler the same size. The plant operating pressure would remain at 120 psig. The boilers sizes used would allow the plant to meet the peak load of 95,000 lb/hr with the largest boiler out of service and would allow the plant to turn down to the low steaming rates that it can now achieve.

The boiler burners would be set up to fire natural gas or No. 2 fuel oil. The fuel oil would be a standby fuel used only if the gas supply was interrupted. The new burners would be low NOx burners. Economizers would be provided for the 75,000 lb/hr boilers. Appendix C includes a copy of the manufacturer's information for the new equipment. Boiler efficiency would be 82 percent when firing natural gas and 85 percent when firing fuel oil. New controls would be furnished with the new boilers. The existing fuel oil system would be used to handle the No. 2 fuel oil. The two 75,000 lb/hr boilers would be installed in the same location as two of the existing 50,000 lb/hr boilers, and the space left by removing the third boiler would be vacant. The 20,000 lb/hr boiler would replace the existing firetube boiler in the same location.

Table 16 shows the LCC summary for this alternative. Costs shown are the 1994 net present worth of the LCC of the plant based on a 25-year life. The investment cost listed is the cost of replacing the boilers and for installing the gas supply line to the plant. Appendix D includes a copy of the cost estimate. The electric cost shown is for the entire DDRE facility—the same as the cost shown for the Status Quo alternative since electric power costs will not change for this alternative.

The natural gas cost is higher than the fuel cost for the Status Quo alternative because of the costs currently proposed by the gas supplier. The fuel consumption is lower than the Status Quo alternative because of the improved efficiency of the new boilers. The maintenance labor, maintenance supply, and service costs are the same as for the Status Quo alternative.

Table 16. New gas/oil boiler alternative LCC summary.

Initial investment cost		$5,483,000
Energy costs:		
Electricity	$38,556,000	
Fuel oil	$22,292,000	
Total energy cost		$60,848,000
Recurring maintenance, repair, and custodial costs		$34,192,000
Major repair and replacement costs		$836,000
Net present worth of the LCCs and Benefits		$101,359,000

Alternative 2—Gas/Oil Boilers With Engine Cogeneration and Absorption Chiller

Alternative 2 uses the same boiler replacement scheme as Alternative 1. Additional equipment is installed for the cogeneration system and the installation of the absorption chiller at the EDC facility.

Three engine generator sets would be installed in the space vacated by the third existing boiler. The generator sets used for this study were spark gas engines rated at 1,100 kW prime power and would be furnished with heat recovery silencers and catalyst controllers to limit NOx emissions. The heat recovery silencers would produce saturated steam at 120 psig, which would be used to replace steam produced in the boilers. This steam would be used in an absorption chiller installed in a building addition adjacent to the Eastern Distribution Center (EDC). The engine jacket water heat would be rejected through a new cooling water system installed at the plant. A new cooling tower and pumping system would be provided at the CHP and the EDC to serve the additional cooling loads.

The engine-generator cogeneration system size was selected to baseload the engines most of time while producing steam approximately equal to the summer peak load required by the absorption chiller at the EDC. No sale of power back to the utility is planned. The emissions produced by the engines required that the NOx catalyst be installed to limit the emissions of the engines to permissible levels.

The generators would produce electricity at 4,160 volts, which would be stepped up to the facility distribution voltage of 12.47 kV. One system including a transformer, meters, breakers, and relays would be provided at the CHP to connect the cogeneration system to the existing overhead distribution system outside the plant. Voltage monitoring and relaying equipment would be installed at the Main Outdoor Substation and a fiber optic communication cable would be extended to the CHP. Voltage monitoring would also be installed at the existing recloser to prevent reclosing on a live bus.

The EDC currently has two, 900-ton, electric motor-driven centrifugal chillers. The chillers have been converted to HFC 134a refrigerant. One new, 900-ton, two-stage absorption chiller would be installed to replace the operation of one of the electric chillers. The chiller would use the 120 psig steam produced by the engine generating sets at the CHP. A new cooling tower would be added at the EDC to provide the additional cooling water required by an absorption unit. The chilled water and cooling water systems would be interconnected and a new building was included in the cost estimate to house the new chiller and pumps. The water heating system at the EDC, which is now fired by oil in the summer, would also use some of the steam produced by the cogeneration system. Some steam would have to be wasted to the atmosphere when the cooling loads in EDC were low in the periods before the heating season begins. Table 17 shows the LCC summary for this alternative. Costs shown are the 1994 net present worth of the LCC of the plant based on a 25-year life.

The investment cost listed is the cost of replacing the boilers as in the previous alternatives and for installing the gas supply line to the plant. The gas line cost for this option is higher than the previous option because a larger supply line is required for the increased fuel consumption of the cogeneration system. The investment cost also includes the cost of the engine generators sets, cooling tower and pumps, and electrical equipment installed for the cogeneration system. The cost for installing the absorption chiller and cooling tower at the EDC is also included.

The electric cost shown is for the entire DDRE facility with the purchase cost used in the previous alternatives reduced by the amount of power produced by the cogeneration system and by the reduced power consumption of the chillers at the EDC. The electric cost also reflects the power charge of $1.22 per kW per month charged by the utility to provide power when one of the generators is off-line. Appendix A includes the electric rate schedule.

The natural gas cost is higher than the fuel cost for the previous alternatives because of the increased fuel consumption of the cogeneration system. The recurring

Table 17. New gas/oil boiler with engine cogeneration and absorption chiller in EDC LCC summary.

Initial investment cost		**$14,244,000**
Energy costs:		
Electricity	$20,067,000	
Fuel oil	$48,496,000	
Total energy cost		$68,563,000
Recurring maintenance, repair, and custodial costs		$35,411,000
Major repair and replacement costs		$836,000
Net present worth of the LCCs and benefits		$119,054,000

maintenance costs and the major repair and replacement costs were increased for the additional equipment installed. The service cost for the waste wood disposal is the same as the previous cases.

The energy cost for this alternative is actually higher than the cost for the previous alternatives because of the electric rate schedule for cogeneration and the fuel cost.

Alternative 3—Gas/Oil Boilers With Gas Turbine Cogeneration and Absorption Chiller

Alternative 3 uses the same boiler replacement scheme as Alternative 1. Additional equipment is installed for the cogeneration system and the installation of the absorption chiller at the EDC facility.

One gas turbine-generator set would be installed in the space vacated by the third existing boiler. The generator set used for this study was rated at a nominal 1,000 kW prime power and would be furnished with heat recovery steam generator. The heat recovery steam generator would produce saturated steam at 120 psig, which would be used to replace steam produced in the boilers. This steam would be used in an absorption chiller in the EDC.

The gas turbine-generator cogeneration system size was selected to baseload the unit while producing steam approximately equal to the summer peak load required by the absorption chiller at the EDC. No sale of power back to the utility is planned. The emissions produced by the gas turbine also limited the size so the emissions produced would not trigger the regulations that would require selective catalytic reduction of the NOX in the flue gas.

The generator would produce electricity at 4,160 volts and the electrical connection to the facility distribution system would be similar to the engine cogeneration system in Alternative 2.

The absorption chiller would be installed in the EDC to use the steam in the summer months similarly to Alternative 2. Table 18 shows the LCC summary for this alternative. Costs shown are the 1994 net present worth of the LCC of the plant based on a 25-year life.

The investment cost listed is the cost of replacing the boilers as in the previous alternatives and for installing the gas supply line to the plant. The gas line cost for this option is higher than the gas line cost of Alternative 1 because a larger supply line is required for the increased fuel consumption of the cogeneration system. The

Table 18. New gas/oil boilers with gas turbine cogeneration and absorption chiller in EDC LCC summary.

Initial investment cost		**$12,085,000**
Energy costs:		
Electricity	$32,339,000	
Fuel oil	$32,810,000	
Total energy cost		$65,148,000
Recurring maintenance, repair, and custodial costs		$34,802,000
Major repair and replacement costs		$836,000
Net present worth of the LCCs and benefits		$112,871,000

investment cost also includes the cost of the gas turbine-generator set and electrical equipment installed for the cogeneration system. The cost for installing the absorption chiller and cooling tower at the EDC is also included.

The electric cost shown is for the entire DDRE facility with the purchase cost used in Alternative 1 reduced by the amount of power produced by the cogeneration system and by the reduced power consumption of the chillers at the EDC. The natural gas cost is lower than the fuel cost for the engine-generator alternative because of the decreased fuel consumption of the gas turbine cogeneration system. The recurring maintenance costs and the major repair and replacement costs were adjusted for the equipment installed. The service cost for the waste wood disposal is the same as for the previous cases.

Again, the energy cost for this alternative is actually higher than the cost for Alternative 1 because of the electric rate schedule for cogeneration and the fuel cost.

Alternative 4A—Gas/Oil Boilers With Waste Wood Boiler

Alternative 4 uses a gas/oil boiler replacement scheme similar to that used in Alternative 1. Additional equipment is installed for the waste wood fired boiler. DDRE generates approximately 10,000,000 lb of wood waste per year, mostly in the form of pallets. The cost for disposing of these pallets was $2,250,000 per year. This alternative has been replaced by the options presented in the section “Revision of Status Quo and Alternative 1” (p 49). The wood waste is no longer available due to a recent recycling program in which pallets are rebuilt or reused for other purposes.

The waste wood boiler used for this case is an incinerator style boiler. The material is mass fed into the water wall furnace with a ram type feeder and moves on to a refractory grate. The grate is pulsed or shaken to move the material through the furnace. The burned material moves toward a wet ash pit and the ash is removed by an automated ash scoop. The flue gas from the furnace passes through a packaged

style boiler convection section, fabric filter baghouse, induced draft fan, and up the stack.

The waste wood is collected from a half dozen locations in roll off containers. The purchase of one new truck to handle the containers is included in the cost for this alternative. The waste wood is transported to a new building constructed adjacent to the existing CHP where it is dumped and processed before burning. The processing system will consist of a shredder to reduce the pallets to a top particle size of 8 to 10 in. The pallets would be fed into the shredder with a small skid-steer loader. The shredded material would discharge onto a belt conveyor and move to a storage bin. The bin bottom would be a walking floor that would feed the material out of the bin, onto conveyors, and then to the boiler feed hopper. The feed from the storage bin to the boiler would be an automated operation. Table 19 shows the LCC summary for this alternative. Costs shown are the 1994 net present worth of the LCC of the plant based on a 25-year life.

The investment cost listed is the cost of replacing the boilers as in the previous alternatives and for installing the gas supply line to the plant. The investment cost also includes the cost of the waste wood fired boiler, the waste wood handling and processing equipment, and a building to house the processing facility.

The electric cost shown is for the entire DDRE facility with the purchase cost used in Alternative 1. The natural gas cost is lower than the fuel cost for the Alternative 1 because of the decreased fuel consumption due to the steam production of the waste wood fired boiler. The recurring maintenance costs and the major repair and replacement costs were adjusted for the additional equipment installed. The cost of two laborers was added, one to drive the truck to collect the waste wood and one to feed the wood into the shredder. The service cost was reduced to reflect the reduced volume of wood waste sent for disposal.

Table 19. New gas/oil boilers with waste wood boiler.

Initial investment cost		**$14,308,000**
Energy costs:		
Electricity	$38,556,000	
Fuel oil	$19,145,000	
Total energy cost		$57,701,000
Recurring maintenance, repair, and custodial costs		$11,469,000
Major repair and replacement costs		$836,000
Net present worth of the LCCs and benefits		$84,314,000

Alternative 4B—Gas/Oil Boilers With Waste Wood Boiler and Absorption Chiller

Alternative 4B uses the same equipment as Alternative 4A with the addition of the absorption chiller at the EDC facility. The absorption chiller would be installed in the EDC to use the steam in the summer months similarly to Alternative 2.

Table 20 shows the LCC summary for this alternative. Costs shown are the 1994 net present worth of the LCC of the plant based on a 25-year life.

The investment cost listed is the cost given in Alternative 4A plus the added cost for installing the absorption chiller and cooling tower at the EDC.

The electric cost shown is for the entire DDRE facility with the purchase cost used in Alternative 1 reduced by the amount of power used by the one electric chiller at the EDC. The natural gas cost is higher than Alternative 4A because the waste wood boiler will not provide all of the steam used by the absorption chiller. The recurring maintenance costs, the major repair and replacement costs, and the service cost are the same as in Alternative 4A.

Alternative 5—New Plant Options

The new plant options were created with the use of CHPECON, the central heating plant economic evaluation program written for USACERL. CHPECON provides a 25-year economic analysis for newly constructed plants, including initial investment costs, fuel costs, annual operation and maintenance (O&M) costs, and major repair and replacement costs. CHPECON includes options that evaluate cogeneration plants and most currently available fossil fuel-burning boiler systems. The cases investigated for DDRE include a new gas-fired plant, a new No. 6 oil-fired plant, a new No. 2 oil-fired plant, and a new gas-fired cogeneration plant. DDRE base electricity costs and service charges for wood waste disposal were included in the data analysis to allow accurate comparison of the CHPECON data to the other modernization alternatives.

Table 20. New gas/oil boilers with waste wood boiler and absorption chiller in EDC LCC summary.

Initial investment cost		**$15,849,000**
Energy costs:		
Electricity	$37,359,000	
Fuel oil	$19,361,000	
Total energy cost		$56,720,000
Recurring maintenance, repair, and custodial costs		$11,469,000
Major repair and replacement costs		$836,000
Net present worth of the LCCs and benefits		$84,875,000

New Natural Gas-Fired Plant

The new plant includes three, 29,000 lb/hr steam boilers. The number and size of boilers was calculated by the CHPECON program based on average monthly steam flow data from DDRE. The boilers would be fitted with gas/oil burners and boiler efficiency would be 80.6 percent when firing natural gas. Either No. 6 oil or No. 2 oil would be used as the reserve fuel for use during natural gas supply interruptions. Table 21 shows the LCC summary for this alternative. Costs shown are the 1994 net present worth of the LCC of the plant based on a 25-year life. The investment cost listed is the cost of building the new facility and installing the gas supply line to the plant. Appendix E includes a copy of the CHPECON results. The electric cost shown is for the entire DDRE facility and is the same as the cost shown for the Status Quo alternative since electric power costs will not change for this new plant option.

New No. 6 Oil-Fired Plant

This option is essentially the same as the new natural gas-fired plant option. The new plant includes three, 29,000 lb/hr steam boilers. The number and size of boilers was calculated by the CHPECON program based on average monthly steam flow data from DDRE. Boiler efficiency would be 85.5 percent when firing No. 6 oil. Table 21 shows the LCC summary for this alternative. Costs shown are the 1994 net present worth of the LCC of the plant based on a 25-year life. The investment cost listed is the cost of building the new facility. A copy of the CHPECON results is in Appendix E. The electric cost shown is for the entire DDRE facility and is the same as the cost shown for the Status Quo alternative since electric power costs will not change for this new plant option.

Table 21. New plant options cost summary.

Option	New Plant Natural Gas	New Plant #6 Oil	New Plant #2 Oil	Cogeneration Natural Gas
Investment	5064021	5064021	5064021	11215030
Plant energy cost	32558311	31337353	34866489	70668316
Annual O&M	8200308	8126830	8126830	12755592
Non-annual O&M	246468	246468	246468	1153219
Service cost	26000000	26000000	26000000	26000000
Base electricity	38556000	38556000	38556000	38556000
Demolition	900000	900000	900000	900000
Electricity credit	0	0	0	38556000
Total LCC	**111525108**	**110230672**	**113759808**	**122692157**

New No. 2 Oil-Fired Plant

As in the previous two options, the new plant includes three 29,000 lb/hr steam boilers. The number and size of boilers was calculated by the CHPECON program based on average monthly steam flow data from DDRE. Heating plant efficiency would be 84.0 percent when firing No. 2 oil. Table 21 shows the LCC summary for this alternative. Costs shown are the 1994 net present worth of the LCC of the plant based on a 25-year life. The investment cost listed is the cost of building the new facility. Appendix E includes a copy of the CHPECON. The electric cost shown is for the entire DDRE facility and is the same as the cost shown for the Status Quo alternative since electric power costs will not change for this new plant option.

New Natural Gas-Fired Plant With Cogeneration

The new plant includes three steam boilers with a cogeneration system sized for 94,000 lb/hr. The number and size of boilers was calculated by the CHPECON program based on average monthly steam flow data from DDRE. The boilers would be fitted with gas/oil burners. Boiler efficiency would be 80.5 percent when firing natural gas. Either No. 6 or No. 2 oil would be used as the reserve fuel in case the natural gas supply is interrupted. Table 21 shows the LCC summary for this alternative. Costs shown are the 1994 net present worth of the LCC of the plant based on a 25-year life. The investment cost listed is the cost of building the new facility and installing the gas supply line to the plant. Appendix E includes a copy of the CHPECON results. The electric cost shown is for the entire DDRE facility and is the same as the cost shown for the Status Quo alternative since electric power costs will not change for this new plant option. The electricity credit calculated by CHPECON was greater than the actual base electricity costs reported, so the electricity credit was reduced to the amount previously spent on electricity.

REEP Analysis

Description of Technology

The Renewables and Energy Efficiency Planning (REEP) computer program was developed by the Army Corps of Engineers at the Construction Engineering Research Laboratories (USACERL) in Champaign, IL. This program allows for the analysis of 78 Energy Conservation Opportunities (ECOs) at 110 Army installations. The program has eight basic categories of ECOs: lighting, electrical, building envelope, HVAC, water, utilities, renewables, and miscellaneous.

The ECOs are evaluated for their energy savings potential, financial viability, and pollution abatement potential. The core of the program consists of a database that has over 100 entries of specific data for each Army installation and a set of algorithms for each ECO. The program user selects the ECO(s) of interest and the program evaluates the ECO(s) at user-selected installations using the installation-specific data.

Installation-specific data includes thousands of square feet of 10 different building types, weather information, capacities of heating and cooling equipment, and utility rate information. The financial portion of the evaluation performs an Energy Conservation Investment Program (ECIP) type analysis and calculates simple payback, savings-to-investment ratio (SIR), and adjusted internal rate of return. The pollution portion of the program calculates the tonnage of six different types of pollutants that would be abated based on how much energy an ECO would conserve and regional characteristics of how electricity is produced.

The Renewables and Energy Efficiency Planning program analysis was performed at USACERL for DDRE. Appendix F gives the results of the REEP analysis. The REEP analysis revealed many possibilities for energy savings at DDRE. The implementation of 4-ft fluorescent lighting could save more than $225,000 annually with a simple payback of just over 8 years. Use of compact fluorescent lighting has the potential to save over $30,000 annually with a simple payback of 1.17 years. Over $80,000 in annual savings may be realized by replacing high wattage incandescent lights. The addition of ultra low flow toilets, faucet aerators, flush valve retrofits, and low flow shower heads could save over $50,000 annually with a simple payback of less than 3.28 years. Additionally, REEP calculated the potential resource (MBtu/year) and pollution (tons/year or lb/year) savings for each energy conservation opportunity (ECO). Table 22 lists the energy conservation opportunities.

Initial Recommendation

Table 23 includes a summary of the life cycle costs of the alternatives studied and Table 24 shows a summary of the life cycle costs of the new plant options. As mentioned in chapter 6, Table 25 shows the emissions calculated for the alternate schemes studied. Emission factors used in the calculations were taken from EPA Publication AP-42 and vendor predicted data.

Table 22. Selected REEP analysis energy conservation opportunities.

Opportunity	Number of Units	Dollars Invest	Dollars Saved/yr	Simple Payback	Pollution SOx	Abated in NOx	tons/yr CO_2
4-ft fluorescent	15,337.00	1,867,779.00	229,773.00	8.13	31.44	9.07	2,459.62
Comp fluorescent	3,676.00	35,333.00	30,282.00	1.17	4.25	1.23	332.87
Incandescent	3,176.00	634,600.00	82,356.00	7.71	11.57	3.34	904.97
Toilets	273.00	87,936.00	26,797.00	3.28	0.00	0.00	0.00
Aerators	226.00	1,277.00	2,566.00	0.50	0.28	0.08	22.93
Flush valves	217.00	2,087.00	14,825.00	0.14	0.00	0.00	0.00
Shower	75.00	1,697.00	7,395.00	0.23	0.85	0.25	71.01

Table 23. Summary of alternative costs.

Alternative	Status Quo	1	2	3	4A	4B
Investment	0	5,483,000	14,244,000	12,085,000	14,308,000	15,849,000
Energy cost:						
Electricity	38,556,000	38,556,000	20,067,000	32,339,000	38,556,000	37,359,000
Natural gas	20,258,000	22,292,000	48,496,000	32,810,000	19,145,000	19,361,000
Total energy	58,814,000	60,848,000	68,563,000	65,148,000	57,701,000	56,720,000
Annual O&M	34,192,000	34,192,000	35,411,000	34,802,000	11,469,000	11,469,000
Major repair	4,361,000	836,000	836,000	836,000	836,000	836,000
Total LCC	**97,368,000**	**101,359,000**	**119,054,000**	**112,871,000**	**84,314,000**	**84,875,000**

Table 24. New plant options cost summary.

Option	New Plant Natural Gas	New Plant #6 Oil	New Plant #2 Oil	Cogeneration Natural Gas
Investment	5,064,021	5,064,021	5,064,021	11,215,030
Plant energy cost	32,558,311	31,337,353	34,866,489	70,668,316
Annual O&M	8,200,308	8,126,830	8,126,830	12,755,592
Non-annual O&M	246,468	246,468	246,468	1,153,219
Service cost	26,000,000	26,000,000	26,000,000	26,000,000
Base electricity	38,556,000	38,556,000	38,556,000	38,556,000
Demolition	900,000	900,000	900,000	900,000
Electricity credit	0	0	0	38,556,000
Total LCC	**111,525,108**	**110,230,672**	**113,759,808**	**122,692,157**

Table 25. Emissions for alternate schemes (tons / year).

Alternative	TSP	PM_{10}	SO_2	CO	NO_x	VOCs	Lead
Status Quo: (No. 6 Oil)	12.9	8.1	169.1	4.7	51.9	1.1	0.004
Alternate 1: Gas/oil boilers	0.9	0.9	0.1	7.9	10.5	7.5	—
Alternate 2: Gas/oil boilers and engine cogeneration	1.2	1.2	0.2	28.7	27.6	20.0	—
Alternate 3: Gas/oil boilers and gas turbine cogeneration	1.1	1.1	0.1	14.9	35.1	9.2	—
Alternate 4: Gas/oil boilers and waste wood boiler	4.3	4.3	0.5	26.7	10.3	7.1	0.004

Alternative 4A (detailed in Appendix G) was the recommended alternative based on the lowest LCC. This alternative includes new gas/oil boilers in the CHP, renovation of the existing plant equipment, and a waste wood fired boiler with the associated waste wood processing facility. Due to a significant reduction in the available wood waste supply, the alternatives using wood waste are no longer feasible. As a result, the Status Quo option was studied in more detail. This is documented in the next section.

Boiler Useful Life Study

To determine the remaining useful life of the CHP boilers, a Boiler Useful Life Study (BULS) was performed by Boiler Inspection Services Company (BISC) on Boiler No. 3 at DDRE. A pressure vessel evaluation was performed on the CHP deaerator by BISC as well. The boiler evaluation was based on information obtained through visual inspection, nondestructive examination, metallurgical analysis of a sample of one of the boiler's tubes, and O&M data.

The nondestructive examination included magnetic particle testing (MT), remote field eddy current (RFEC) testing, and ultrasonic testing (UT).

Magnetic particle testing was performed on circumferential and accessible longitudinal welds in the steam drum. These tests revealed no significant cracking. MT of the boiler tube ends and tubesheet ligament areas did not reveal indications of significant cracking or relevant defects. The visual inspection revealed no significant scale accumulation on the water side of the boiler. RFEC testing of 320 generating bank boiler tubes revealed no tubes with greater than 30 percent wall loss, indicating good water chemistry maintenance. Ultrasonic testing of the steam drum, water (mud) drum, waterwall headers, and accessible tubes indicated no abnormal thinning of metal in

any of these components. The metallurgical analysis of one boiler tube sample taken from a target-wall tube (tubes opposite the burners) indicated no significant microstructure or hardness changes in the metal. X-ray diffraction analysis of the light scale from the water side of the tube revealed that the scale was composed of magnetite and hydroxylapatite. These scale components are the type typically found in boilers and the low accumulation was considered good for a 1951 boiler.

The safety relief valves were visually inspected and appeared to be in good condition, though the relief valve drain lines should be piped away from the boiler insulation to prevent insulation degradation. The boiler plant operators test the relief valves annually. Evidence of past leakage was observed at the packing gland of the main steam stop valve. Plant records indicate that the valve gland was repacked during June 1995 maintenance. The burners and boiler tubes show no signs of improper combustion or flame impingement. The firebox refractory appears to be in good condition, though some gaps appear to be developing in the front wall approximately 20 ft from the floor. The burner throat refractory is in good condition. The external casing of the boiler is in good condition, exhibiting no indications of deformation, bulging, or deterioration. Corrosion was observed underneath the boiler stack flashing hood and should be monitored. Repair will become necessary if excessive corrosion occurs in this area. Some tubes are sagging in the rear (dead-air) section of the boiler. These tubes should be monitored and repaired if there is a significant increase in sagging. Additionally, the outside refractory at the rear of the boiler should be repaired to prevent the introduction of cold air to the boiler. Excess corrosion of the boiler manway covers was observed.

It was recommended that the following maintenance be performed on Boiler 3 at DDRE:

1. The boiler manway covers should be replaced and the gasket sealing areas repaired as necessary.
2. The boiler refractory insulation lining should be repaired.
3. Divert the piping from the safety relief valve drain lines away from the insulation.
4. Monitor the boiler stack at the flashing hood and repair when necessary.
5. Monitor the sagging tubes in the rear section of the boiler and repair rear refractory.

By performing this maintenance and continuing the current preventive maintenance and water chemistry programs, this boiler can be expected to last up to 10 years. It would be beneficial to perform a visual inspection of the internal and external components of Boilers 1 and 2 to identify any minor repairs needed, with special atten-

tion paid to the issues addressed above for Boiler 3. Due to similar operation and maintenance histories, it seems reasonable to expect material thickness and quality in Boilers 1 and 2 similar to that found in Boiler 3; with normal maintenance Boilers 1 and 2 will also last 10 years. Another boiler useful life study should be performed in 10 years to monitor the condition of the boilers and their components.

Revision of Status Quo and Alternative 1

On eliminating the possibility of implementing Alternative 4A/4B due to the great reduction in available wood waste, it was determined that the best option would be either to maintain the existing CHP or to proceed with plans to construct a new CHP. To determine the optimum choice, a Boiler Useful Life Study (BULS) was performed on Boiler 3. The BULS determined the remaining useful life of the boiler to be at least 10 years. The status quo option was then re-evaluated and the new recommended option was chosen based on a comparison of Status Quo cases and Alternative 1 (new plant with gas/oil boilers).

The negotiation for the supply of natural gas to the facility is currently in progress. The gas pricing currently stated by the gas supply company, UGI, has the natural gas price competitive with the price of No. 2 fuel oil ($4.32/MBtu) if UGI pays the cost of the supply line. The price of natural gas could be as low as $2.10/MBtu (interruptible rate) if the Government pays for the natural gas supply line for UGI. The two parts of the natural gas price include the current pipeline (UGI) transmission rate of $0.10 to $0.15/MBtu and the current natural gas price of $1.88/MBtu reported by Defense Fuels Supply to UGI. The cost of the natural gas supply line was previously estimated to be $1,375,000. If the gas company were to pay for the pipeline, the natural gas price would be increased by an amount in accordance with amortizing the cost of the pipeline incurred by the gas company over approximately 6 years (at least $1/MBtu). The existing oil supply system would be maintained to enable the CHP to burn oil when the natural gas supply is interrupted.

Presently, the facility plans to convert to firing No. 4 oil from No. 6 oil. The price for No. 4 oil is reported to be equivalent to the price of No. 6 oil. This change should only result in an efficiency decrease of 0.5 percent and will require new burner tips for No. 4 oil (per conversation with boiler consultant). The required heating temperature of the No. 4 oil and the oil pump specifications should be reviewed, but only minor adjustments are expected since the properties of No. 4 oil and No. 6 oil are very similar (Appendix H).

Status Quo B

Status Quo was revised to delay boiler replacement until the year 2005, burning No. 4 oil before and after boiler replacement. The price for No. 4 oil used in this analysis was $3.32/MBtu. Table 26 summarizes the life cycle costs and Appendix B includes the Status Quo program output.

Status Quo C

Status Quo was revised to delay boiler replacement until the year 2005, burning No. 4 oil until 2005 and burning natural gas after boiler replacement. The price for No. 4 oil used in this analysis was $3.32/MBtu and the price for natural gas used was $2.10/MBtu. The price of the natural gas pipeline to serve the facility ($1,375,000) was also included in this analysis as an investment cost. The life cycle costs are summarized in Table 26 and the Status Quo program output is in Appendix B.

Status Quo D

Status Quo was revised to delay boiler replacement until the year 2005, burning natural gas before and after boiler replacement. The price for natural gas used in this analysis was $2.10/MBtu and the price of the natural gas pipeline to serve the facility ($1,375,000) was included as an initial investment. Table 26 summarizes the life cycle costs and Appendix B includes the Status Quo program output.

Status Quo E

Status Quo was revised to delay boiler replacement until the year 2009, burning natural gas before and after boiler replacement. The price for natural gas used in this analysis was $2.10/MBtu and the price of the natural gas pipeline to serve the facility ($1,375,000) was included as an initial investment. Table 26 summarizes the life cycle costs and Appendix B includes the Status Quo program output.

Alternative 1A

Alternative 1 was revised using the gas price of $2.10/MBtu (instead of the gas price of $4.32/MBtu previously used) after discussing potential fuel prices for DDRE with the gas company, UGI. Table 26 summarizes the life cycle costs and Appendix B includes the Status Quo program output.

Table 26. Summary of revised Status Quo and Alternative 1 costs (1994 $).

	Status Quo	Status Quo B	Status Quo C	Status Quo D	Status Quo E	Alternative 1A
New boilers:	2004	2005	2005	2005	2009	1997
Fuel used (before/after):	(#6 oil / #2 oil)	(#4 oil / #4 oil)	(#4 oil / Gas)	(Gas / Gas)	(Gas / Gas)	
Investment	0	0	1,375,000	1,375,000	1,375,000	5,482,856
Energy cost:						
Electricity	38,556,000	38,556,000	38,556,000	38,556,000	38,556,000	38,556,000
#6 Oil	5,057,553					
#4 Oil		18,833,843	7,004,891			
#2 Oil	15,200,770					
Natural gas			7,423,539	11,565,537	11,834,815	11,161,430
Total energy	58,814,000	57,389,843	52,984,430	50,121,537	50,390,815	49,717,080
Annual O&M	34,192,000	34,192,480	34,192,480	34,192,480	34,192,000	34,192,480
Major repair	4,361,000	4,321,984	4,321,984	4,321,984	3,870,201	836,474
Total LCC	**97,368,000**	**95,904,307**	**92,873,894**	**90,011,001**	**89,828,496**	**90,229,240**

8 Conclusions and Recommendations

This study concludes that the most cost-effective technologies (with the lowest total LCC) for meeting current and future thermal and electrical needs at DDRE are those outlined in option “Status Quo E.” The second and third lowest Total LCC are those of Status Quo D and Alternative 1A, respectively. These options include the cost of installing the gas line and enjoy the benefits of purchasing natural gas at a rate of $2.10/MBtu over the entire analysis period. The alternative fuel for any of these operations could be No. 4 oil, which would be burned at times when the natural gas supply was interrupted. A comparison of Status Quo D and Status Quo C shows that converting to natural gas before the year of boiler replacement would significantly reduce the LCC of the CHP by reducing fuel costs. A comparison of Status Quo D and Status Quo E shows that the LCC would be slightly reduced if subsequent boiler testing (recommended previously in BULS section) concluded that the existing CHP could, in fact, last until the year 2009.

Considering the current trend of reduced Government funding, it is recommended that DDRE pursue option “Status Quo E,” provided that funding for the natural gas supply line can be obtained. In the event that funding for replacing the boilers becomes available, the small difference in LCC between the recommended option (Status Quo E) and Alternative 1A should not deter DDRE from upgrading the existing facility. The minor improvements recommended in the Boiler Useful Life Study should be completed in 1996 regardless of the option chosen because it will take more than 1 year to secure funding and implement the recommended option. The current maintenance and water treatment programs should be continued to ensure reliable CHP performance.

It is also recommended that another Boiler Useful Life Study be completed between years 2000 and 2005 to reevaluate the remaining useful life of the boilers. Conversion to natural gas in the near future is recommended as long as fuel rates remain comparable to those currently available.

Appendix A: Electric Rate Schedule

Supplement No. 37
Electric Pa. P.U.C. No. 200
Eighth Revised Page No. 28
Canceling Seventh Revised Page No. 28

PENNSYLVANIA POWER & LIGHT COMPANY

RATE SCHEDULE LP-5
LARGE GENERAL SERVICE AT 69,000 VOLTS OR HIGHER (C)

APPLICATION RATE SCHEDULE LP-5

This rate schedule is for large general service supplied from available lines of 69,000 volts or higher, with customer furnishing and maintaining all equipment necessary to transform the energy from the line voltage. It applies to 3 phase, 60 Hertz service and also to 1 phase, 25 Hertz service at existing locations as of August 28, 1981. (C)

NET MONTHLY RATE (Effective 4-1-93)

$4.39 per kilowatt for all kilowatts of the Billing KW.

4.86 cts. per KWH for the first 150 KWH per kilowatt of the Billing KW but not more than 1,200,000 KWH.
4.43 cts. per KWH for the next 100 KWH per kilowatt of the Billing KW.
3.68 cts. per KWH for the next 150 KWH per kilowatt of the Billing KW.
3.21 cts. per KWH for all additional KWH.

A credit of $0.85 is applied to all Billing KW when customer takes service at 230,000 volts.

The Energy Cost Rate applies to all KWH supplied under this rate.

The Minimum Billing Demand is 300 KW. (C)

The Net Monthly Rate Minimum is $1,317.00. (C)

FACILITY CHARGE

In addition to the above charges, for 25 Hertz service the customer pays the Company $3,457 per month for use of Company facilities. (C)

BILLING KW

The Billing KW is the average number of kilowatts supplied during the 15 minute period (1 hr. period for 230,000 volt service) of maximum use during the current billing period, except that where a 1 hr. period of maximum use was in effect as of August 28, 1981 it may be continued for that customer.

Time-of-Day metering and billing is available on request for an additional charge of $12.00 per month for a minimum period of one year. The Billing KW is the average number of kilowatts supplied during the 15 minute (1 hr.) period of maximum use during the on-peak hours of the current billing period.

ON-PEAK HOURS

On-peak hours for billing purposes are 7 a.m. to 3 p.m., 8 a.m. to 4 p.m., or 9 a.m. to 5 p.m. local time, at the option of the customer, Mondays to Fridays inclusive except New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day. The Company's system on-peak period is 7 a.m. to 9 p.m. local time.

OPTIONAL INTERRUPTIBLE POWER

Optional Interruptible Power is available to customers served under this rate schedule with at least 1,000 KW of year-round Interruptible Power who contract to accept interruptible service for at least one year, as detailed in this provision. (C

NET MONTHLY RATE (Effective 4-1-93)

$9.60 per kilowatt for all kilowatts of the Billing KW.

3.21 cts. per KWH for first 400 hours use of Billing KW
2.14 cts. per KWH for all additional KWH.

A credit of $0.85 is applied to all Billing KW when customer takes service at 230,000 Volts.

The Energy Cost Rate applies to all KWH supplied under this rate.

The Minimum Billing Demand is 300 KW. (C

The Net Monthly Rate Minimum is $2,880.00. (C

BILLING KW

The monthly Billing KW is calculated as:

Billing KW = Firm Power + [Interruptible Power X (1 - Average On-peak Load Factor)] ((

ON-PEAK HOURS

On-peak hours for billing purposes are 7 a.m. to 7 p.m. local time, Mondays to Fridays inclusive except New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day.

MAXIMUM ON-PEAK DEMAND

Maximum On-peak Demand is the average number of kilowatts supplied during the 15 minute period (1 hr. period for 230,000 volt service) of maximum use during the On-peak Hours of the current billing period, except that where a 1 hour period of maximum use was in effect as of August 28, 1981, it may be continued for that customer. ((

(C) Indicates Change (Continued)

Issued October 19, 1993 Effective December 20, 1993

PPL MARKETING 237 P03 JUN 17 '94 14:49

PENNSYLVANIA POWER & LIGHT COMPANY

Supplement No. 35
Electric Pa. P.U.C. No. 200
Second Revised Page No. 108
Canceling First Revised Page No. 108

RULES FOR ELECTRIC SERVICE

RULE 6A - STAND-BY SERVICE FOR QUALIFYING FACILITIES

A. APPLICATION

(1) The Company will supply Stand-by Service under terms of this Rule to: (a) Qualifying Facilities (QFs) as defined in the Public Utility Regulatory Policies Act of 1978, or (b) a customer that contracts with a QF and that must be served under the requirements of either federal or state law.

(2) Stand-by Service is supplied only where the Company has available capacity and facilities adequate for the service requested and only pursuant to a power purchase or interconnection agreement with the Company.

B. TYPES OF STAND-BY SERVICE AVAILABLE

(1) Supplementary Power is electric energy or capacity supplied by the Company and regularly used in addition to that energy or capacity supplied by that QF. All energy or capacity supplied by the Company under this rule shall be Supplementary Power unless it is provided as Back-up Power or Maintenance Power as defined below.

(2) Back-up Power is electric energy or capacity supplied by the Company to replace energy or capacity regularly supplied by the QF's equipment when such equipment is not available during an outage for other than prescheduled maintenance. Back-up Power shall be limited to 1,314 hours during the most recent consecutive twelve-month billing periods. Any additional power supplied above the 1,314 hour limit shall be billed as Supplementary Power. The QF must provide the Company with a written notification of the use of Back-up Power within seven business days after conclusion of the use. This notification must include the day and time at which the use of Back-up Power began, the reason for the usage, and the actual duration of the use of Back-up Power.

(3) Maintenance Power is electric energy or capacity supplied by the Company during a prescheduled maintenance outage of the QF's generating equipment. Maintenance Power is available for not more than 70 days per year and must be scheduled during the periods March 16 to May 31, and September 16 to November 30. The QF must confirm with the Company in writing 60 days before receiving such power and indicate the required capacity and proposed duration of Maintenance Power use. The required capacity and proposed duration of Maintenance Power use can be changed after the 60-day notice is given, but before the outage occurs, by mutual written agreement between the Company and the QF. The QF must provide the Company a written notification of the use of Maintenance Power within seven business days after the conclusion of the use. This notification must include the day and time at which the use of Maintenance Power began and the actual duration of the use of Maintenance Power.

C. INTERCONNECTED AND PARALLEL OPERATION

The QF shall comply with all Company requirements concerning interconnected or parallel operations. These requirements are on file with the Commission as part of the Company's annual PURPA Section 210 filing and/or are contained in power purchase and interconnection agreements between the Company and QFs.

D. INTERRUPTIBLE OPTION

Back-up Power is available on an Interruptible basis to QFs with generators rated in excess of 500 KW. Interruptible Back-up Power may be interrupted when, in the Company's opinion, any generation, transmission, or distribution capacity limitations exist or during periods of economic load control. Whenever possible, the QF will be notified in advance of a probable interruption and the estimated duration of the interruption. If the QF fails to interrupt, a penalty of $10.20 per KW shall be billed for each KW that has not been interrupted, in addition to applicable Back-up Power charges. The Company will notify the QF by telephone at the conclusion of the interruption. A credit of $0.35/KW for Service at 480 volts or less, $0.30/KW for Service at 12,000 volts, $0.25/KW for Service at 69,000 volts or higher will be applied to the QF's monthly bill for each KW interrupted in any month in which an interruption is requested. No credits will be applied if the QF fails to interrupt all Back-up Power. (I)

(I) Indicates Increase

(Continued)

Supplement No. 37
Electric Pa. P.U.C. No. 200
Sixth Revised Page No. 28A
Canceling Fifth Revised Page No. 28A

PENNSYLVANIA POWER & LIGHT COMPANY

RATE SCHEDULE LP-5 (CONTINUED)

ON-PEAK LOAD FACTOR

On-peak Load Factor for billing purposes is the ratio of the kilowatt-hours supplied during the On-peak Hours to the product of the Maximum On-peak Demand and the number of On-peak Hours for a billing period.

AVERAGE ON-PEAK LOAD FACTOR

Average On-peak Load Factor is the average of the On-peak Load Factors for the twelve months of the prior calendar year. Average On-peak Load Factor is recalculated annually and applied to service billed on and after April 1 of the current year under the Optional Interruptible Power provision. The Company may modify the On-peak Load Factors for the twelve months of the prior calendar year to reflect operations expected under this provision.

FIRM POWER

Firm Power is the level of KW demand which the customer has no obligation to curtail during an interruption of service called by the Company. The initial level of Firm Power shall be specified in the contract. This initial level will be adjusted by the Company to the level of Firm Power actually achieved by the customer during an emergency or an emergency test interruption period. The adjusted level shall become the level of Firm Power for the remaining term of the contract or until a new level of Firm Power is achieved during a subsequent emergency or an emergency test interruption period. The level of Firm Power shall not be adjusted below the initial level of Firm Power specified in the contract.

INTERRUPTIBLE POWER

Interruptible Power is the Maximum On-Peak Demand less the Firm Power.

HOURS OF INTERRUPTION

Load interruptions may be called by the Company as required for economic load control, for system and local emergencies, and for tests of the customer's ability and readiness to interrupt load during an emergency. The frequency of load interruptions shall be no less than once per year; or no more than 20 per calendar year with such interruptions being no more than 10 hours in any one day; or more often than five days in any single month, or more than 200 hours in a calendar year. Whenever possible, the customer will be notified in advance of a probable interruption and the estimated duration of the interruption. The customer is obligated to interrupt load during emergencies and emergency tests, but has the option to interrupt, or accept an additional charge for continued use, during periods of economic load control.

The Company may cancel the contract for interruptible service if the customer fails to interrupt during an emergency or an emergency test interruption period.

The charge for continued use (KWH) of interruptible load (KW) during a period of economic load control is the sum of the charges under the rate plus the Company's estimated PJM Interconnection billing rate applied to all KWH used during the interruption period.

The additional charge for not interrupting load (KW) when called for during an emergency or an emergency test interruption period is: $15.30 per KW for all KW by which the maximum 15 minute (1 hr. for 230,000 volt service) demand (KW) for the period of requested interruption exceeds the Firm Power (KW). This penalty shall be applied separately for each requested interruption, and shall be in addition to all other charges provided for under the rate, including the Company's estimated PJM Interconnection billing rate applied to all KWH used during the emergency or the emergency test interruption period.

INDUSTRIAL DEVELOPMENT INITIATIVES RIDER

The Industrial Development Initiatives Rider included in this Tariff applies to eligible customers served under this Rate Schedule, except for customers served under the Optional Interruptible Power provision or the Economic Development Initiatives Rider.

ECONOMIC DEVELOPMENT INITIATIVES RIDER

The Economic Development Initiatives Rider included in this Tariff applies to eligible customers served under this Rate Schedule, except for customers served under the Optional Interruptible Power provision or the Industrial Development Initiatives Rider.

ELECTRIC VEHICLE RIDER (EXPERIMENTAL)

The Electric Vehicle Rider included in this Tariff applies to eligible customers served under this Rate Schedule.

DEMAND FREE DAYS (EXPERIMENTAL)

A customer taking service under this rate schedule having a monthly maximum demand of 5,000 KW or greater is eligible for Demand Free days. An eligible customer may pre-select three (3) weekdays per week, from Tuesday through Friday, as Demand Free. The demand created by the customer on the pre-selected days will not be used for billing purposes. The customer must specify annually which three weekdays per week will be Demand Free for the succeeding year. Terms and conditions for service under this provision are covered by contract. This provision does not apply to customers served under the Optional Interruptible Power Provision.

The Company will notify the customer by 2:00 p.m. of the weekday preceding a Demand Free day if the Demand Free day is canceled. A Demand Free Day will not be canceled by the Company unless the incremental cost to carry the Company's system load is greater than the sum of the trailing block energy rate under this schedule and the Energy Cost Rate, or the local distribution system has insufficient capacity to meet the expected load.

SPECIAL BASE RATE CREDIT ADJUSTMENT

The Special Base Rate Credit Adjustment included in this Tariff is applied to charges under this rate except for charges made under the Energy Cost Rate and charges made under the State Tax Adjustment Surcharge.

STATE TAX ADJUSTMENT SURCHARGE

The State Tax Adjustment Surcharge included in this Tariff is applied to charges under this rate except for charges made under the Energy Cost Rate.

PAYMENT

The above net rate applies when bills are paid on or before the due date specified on the bill, which is not less than 15 days from the date bill is mailed. When not so paid, the gross rate applies which is the above net rate plus 5% on the first $200.00 of the then unpaid balance of the monthly bill and 2% on the remainder thereof.

CONTRACT PERIOD

Not less than one year.

(C) Indicates Change

Issued October 19, 1993 Effective December 20, 1993

Supplement No. 35
Electric Pa. P.U.C. No. 200
Third Revised Page No. 10C
Canceling Second Revised Page No. 10C

PENNSYLVANIA POWER & LIGHT COMPANY

RULE 6A - STAND-BY SERVICE FOR QUALIFYING FACILITIES (CONTINUED)

E. RATES FOR STAND-BY SERVICE

(1) Supplementary Power is metered and billed separately under the Company's applicable general service rate schedule.

(2) (a) Back-up Power is billed separately. The billing is based on KW demand and KWH registered on the Company's meters. Where such actual KW demand use exceeds the KW specified under paragraph G, such excess KW and, on a percentage basis, the associated KWH shall be billed as Supplementary Power. When metered KW demand use is not available, the KW demand billed will be based on the KW of Back-up Power specified under paragraph G. When metered KWH use is not available, the KWH energy billed under the Back-up Power rates will be calculated by multiplying the KW of Back-up Power specified under paragraph G by the number of hours of the unscheduled outage.

(b) The QF will pay a Monthly Reservation Charge equal to the KW of Back-up Power specified under paragraph G multiplied by the Back-up Power capacity charge. The monthly minimum bill shall be the greater of the Monthly Reservation Charge or charges for actual Back-up Power usage.

(c) Back-up Power will be billed using the following charges: (I)

	Service at 480 Volts or Less	Service at 12,000 Volts	Service at 69,000 Volts or Higher
Capacity Charge	$1.74/KW	$1.69/KW	$1.22/KW
KWH Charge	3.93¢/KWH	3.68¢/KWH	3.22¢/KWH

The Special Base Rate Credit Adjustment, Energy Cost Rate and State Tax Adjustment Surcharge included in this Tariff shall be applied to the above charges.

(3) (a) Maintenance Power is billed separately. The billing is based on the KWH registered on the Company's meters. When metered KWH use is not available, the KWH energy billed under the Maintenance Power rates will be calculated by multiplying the KW of Maintenance Power specified under paragraph G by the number of hours of the use of Maintenance Power.

(b) Maintenance Power will be billed using the following charges: (I)

	Service at 480 Volts or Less	Service at 12,000 Volts	Service at 69,000 Volts or Higher
KWH Charge	3.93¢/KWH	3.68¢/KWH	3.22¢/KW

The Special Base Rate Credit Adjustment, Energy Cost Rate and State Tax Adjustment Surcharge included in this Tariff shall be applied to the above charges.

F. KW DEMAND

The KW Demand is the average number of Kilowatts supplied during the 15 minute period of maximum use during the current billing period.

Comparison of Old and New Electrical Rate Structures

LP-5 69 KV or Higher Supply

Old (effective 4-1-93)	New (effective 9-28-95)
\$4.39 per KW all billing KW	\$6.00 per KW all billing KW
4.86 per KWH first 150 KWH/KW (maximum 1,200,000 KWH)	5.60 per KWH first 200 KWH/KW
4.43 per KWH next 100 KWH/KW	4.80 per KWH next 200 KWH/KW
3.68 per KWH next 150 KWH/KW	4.20 per KWH all additional KWH
3.21 per KWH all additional KWH	

Highlights of major changes are as follows:

a. The Minimum Billing Demand remains 300 KW. The Net Monthly Rate Minimum is increased from \$1,317.00 to \$1800.00.

b. The \$0.85 per KW credit for service at 230,000 volts remains unchanged.

c. Reference to 1 phase, 25 Hertz service is eliminated. The Facility Charge for 25 Hertz service also is eliminated.

d. The additional charge for Time-of-Day metering and billing is increased from \$12.00 per month to \$15.00 per month.

e. The Optional Interruptible Power provision (L5-I) is eliminated.

f. The Demand Free Day provision will terminate on January 1, 1998.

Appendix B: LCC Analyses

LIFE CYCLE COST ANALYSIS STUDY: PERA
LCCID 1.065 DATE/TIME: 01-30-96 14:46:47
PROJECT NO., FY, & TITLE: FY 1994 PERA
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR B&C
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 06

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.75	JUL99-JUL05
ELECT DEMAND	.0	.00	JUL99-JUL05
RESIDUAL OIL	958145.3	3.75	JUL99-JUL05
MAINT LABOR	482631.0	.00	JUL99-JUL05
MAINT SUPPLY	74076.0	.00	JUL99-JUL05
SERVICE COST	2250000.0	.00	JUL99-JUL05
BREECH	2425.0	.00	JAN 99
OPACMONITOR	127628.0	.00	JAN 03
STACK	53577.0	.00	JAN 05
DRUMCTL	6381.0	.00	JAN 99
DRUMCTL	6381.0	.00	JAN 99
FW_REG	2680.0	.00	JAN 99
I_FAN	45467.0	.00	JAN 99
RELVALVE	6892.0	.00	JAN 99
WTBOILER	335024.0	.00	JAN 05
WTBURNER	95721.0	.00	JAN 05
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
FLAMESAFE	48620.0	.00	JAN 02
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRRECV	989.0	.00	JAN 99
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99
CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 05
FEEDPUMP	48499.0	.00	JAN 99
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99

LIFE CYCLE COST ANALYSIS STUDY: PERA
LCCID 1.065 DATE/TIME: 01-30-96 14:46:47
PROJECT NO., FY, & TITLE: FY 1994 PERA
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR B&C
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 06

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.75	JUL99-JUL05
ELECT DEMAND	.0	.00	JUL99-JUL05
RESIDUAL OIL	958145.3	3.75	JUL99-JUL05
MAINT LABOR	482631.0	.00	JUL99-JUL05
MAINT SUPPLY	74076.0	.00	JUL99-JUL05
SERVICE COST	2250000.0	.00	JUL99-JUL05
BREECH	2425.0	.00	JAN 99
OPACMONITOR	127628.0	.00	JAN 03
STACK	53577.0	.00	JAN 05
DRUMCTL	6381.0	.00	JAN 99
DRUMCTL	6381.0	.00	JAN 99
FW_REG	2680.0	.00	JAN 99
I_FAN	45467.0	.00	JAN 99
RELVALVE	6892.0	.00	JAN 99
WTBOILER	335024.0	.00	JAN 05
WTBURNER	95721.0	.00	JAN 05
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
FLAMESAFE	48620.0	.00	JAN 02
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRRECV	989.0	.00	JAN 99
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99
CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 05
FEEDPUMP	48499.0	.00	JAN 99
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99

```
LCCID  1.065                     DATE/TIME:  01-30-96  14:46:47
PROJECT NO., FY, & TITLE:      FY 1994     PERA
INSTALLATION & LOCATION: DDRE     PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

BASIC INPUT DATA SUMMARY

WATERSTOR	38544.0	.00	JAN 99
PORT_EXTGSHR	1884.0	.00	JAN 99
HEATER	19448.0	.00	JAN 02
PUMP	19448.0	.00	JAN 02
UNLOADPUMP	17746.0	.00	JAN 99
SZSOFT	261637.0	.00	JAN 06
DOORS	10210.0	.00	JAN 99
LIGHTS	2553.0	.00	JAN 99
ROOF	9.0	.00	JAN 99
SIDING	26.0	.00	JAN 99
SUMPPUMPSUB	7051.0	.00	JAN 99
WINDOWS	523.0	.00	JAN 99

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	17.27	164127.0	.0	JAN99-JAN06
RESID	3.32	288598.0		JAN99-JAN06

```
LCCID  1.065                          DATE/TIME:  01-30-96  14:46:47
PROJECT NO., FY, & TITLE:       FY 1994     PERA
INSTALLATION & LOCATION: DDRE     PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD

                    LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                                    0.

ENERGY COSTS:

ELECTRICITY                           15090230.
RESIDUAL OIL                           7004891.

TOTAL ENERGY COSTS                                   22095120.

RECURRING M&R/CUSTODIAL COSTS                        13768190.

MAJOR REPAIR/REPLACEMENT COSTS                         997668.

OTHER O&M COSTS & MONETARY BENEFITS                         0.

DISPOSAL COSTS/RETENTION VALUE                              0.

LCC OF ALL COSTS/BENEFITS (NET PW)                   36860980.


*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

LCCID 1.065 DATE/TIME: 01-30-96 14:46:47
PROJECT NO., FY, & TITLE: FY 1994 PERA
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL05

PAY	ELECT	RESID	M & R	R / R	OTHER
1	2380234.	1035458.	2247958.	359596.	0.
2	2304982.	1028693.	2147047.	0.	0.
3	2227198.	1019711.	2050665.	0.	0.
4	2157766.	1007898.	1958611.	62490.	0.
5	2086392.	991083.	1870688.	87041.	0.
6	2012787.	970502.	1786713.	0.	0.
7	1920875.	951544.	1706507.	333074.	0.
***	********	7004891.	********	997668.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

```
     LIFE CYCLE COST ANALYSIS                           STUDY: PERA
LCCID  1.065                    DATE/TIME:  01-30-96  14:48:27
PROJECT NO., FY, & TITLE:       FY 1994     PERA
INSTALLATION & LOCATION: DDRE      PENNSYLVANNIA
DESIGN FEATURE: SQNAG2005BLR    D
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 06

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.75	JUL99-JUL05
ELECT DEMAND	.0	.00	JUL99-JUL05
NATURAL GAS	621131.7	2.91	JUL99-JUL05
MAINT LABOR	482631.0	.00	JUL99-JUL05
MAINT SUPPLY	74076.0	.00	JUL99-JUL05
SERVICE COST	2250000.0	.00	JUL99-JUL05
BREECH	2425.0	.00	JAN 99
OPACMONITOR	127628.0	.00	JAN 03
STACK	53577.0	.00	JAN 05
DRUMCTL	6381.0	.00	JAN 99
DRUMCTL	6381.0	.00	JAN 99
FW_REG	2680.0	.00	JAN 99
I_FAN	45467.0	.00	JAN 99
RELVALVE	6892.0	.00	JAN 99
WTBOILER	335024.0	.00	JAN 05
WTBURNER	95721.0	.00	JAN 05
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
FLAMESAFE	48620.0	.00	JAN 02
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRRECV	989.0	.00	JAN 99
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99
CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 05
FEEDPUMP	48499.0	.00	JAN 99
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99

```
LCCID  1.065                        DATE/TIME:  01-30-96  14:48:27
PROJECT NO., FY, & TITLE:           FY 1994     PERA
INSTALLATION & LOCATION: DDRE       PENNSYLVANNIA
DESIGN FEATURE: SQNAG2005BLR
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

BASIC INPUT DATA SUMMARY

WATERSTOR	38544.0	.00	JAN 99
PORT_EXTGSHR	1884.0	.00	JAN 99
HEATER	19448.0	.00	JAN 02
PUMP	19448.0	.00	JAN 02
UNLOADPUMP	17746.0	.00	JAN 99
SZSOFT	261637.0	.00	JAN 06
DOORS	10210.0	.00	JAN 99
LIGHTS	2553.0	.00	JAN 99
ROOF	9.0	.00	JAN 99
SIDING	26.0	.00	JAN 99
SUMPPUMPSUB	7051.0	.00	JAN 99
WINDOWS	523.0	.00	JAN 99

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	17.27	164127.0	.0	JAN99-JAN06
NAT. G	2.10	295777.0		JAN99-JAN06

LCCID 1.065 DATE/TIME: 01-30-96 14:48:27
PROJECT NO., FY, & TITLE: FY 1994 PERA
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQNAG2005BLR
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
ELECTRICITY	15090230.	
NATURAL GAS	4141998.	
TOTAL ENERGY COSTS		19232230.
RECURRING M&R/CUSTODIAL COSTS		13768190.
MAJOR REPAIR/REPLACEMENT COSTS		997668.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		33998090.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LCCID 1.065 DATE/TIME: 01-30-96 14:48:27
PROJECT NO., FY, & TITLE: FY 1994 PERA
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQNAG2005BLR
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL05

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	2380234.	607770.	2247958.	359596.	0.
2	2304982.	602390.	2147047.	0.	0.
3	2227198.	595777.	2050665.	0.	0.
4	2157766.	593028.	1958611.	62490.	0.
5	2086392.	589796.	1870688.	87041.	0.
6	2012787.	582802.	1786713.	0.	0.
7	1920875.	570435.	1706507.	333074.	0.
***	********	4141998.	********	997668.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

```
      LIFE CYCLE COST ANALYSIS                          STUDY: PERB
LCCID  1.065                    DATE/TIME:  01-29-96  15:24:52
PROJECT NO., FY, & TITLE:        FY 1994     PERB7
INSTALLATION & LOCATION: DDRE      PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR     B
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 06

COST / BENEFIT DESCRIPTION	COST IN DOS \$ (\$ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.75	JUL99-JUL05
ELECT DEMAND	.0	.00	JUL99-JUL05
RESIDUAL OIL	860364.7	3.75	JUL99-JUL05
MAINT LABOR	482631.0	.00	JUL99-JUL05
MAINT SUPPLY	74076.0	.00	JUL99-JUL05
SERVICE COST	2250000.0	.00	JUL99-JUL05
WTBOILER	4211724.0	.00	JAN 05
WTBURNER	382884.0	.00	JAN 05
SZSOFT	261637.0	.00	JAN 06

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

ENERGY USAGE: 10**6 BTUS — ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	\$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	17.27	164127.0	.0	JAN99-JAN06
RESID	3.32	259146.0		JAN99-JAN06

```
LCCID  1.065                  DATE/TIME:  01-29-96  15:24:52
PROJECT NO., FY, & TITLE:      FY 1994     PERB7
INSTALLATION & LOCATION: DDRE    PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
ELECTRICITY	15090230.	
RESIDUAL OIL	6290028.	
TOTAL ENERGY COSTS		21380260.
RECURRING M&R/CUSTODIAL COSTS		13768190.
MAJOR REPAIR/REPLACEMENT COSTS		3013931.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		38162380.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LCCID 1.065 DATE/TIME: 01-29-96 15:24:52
PROJECT NO., FY, & TITLE: FY 1994 PERB7
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL05

PAY	ELECT	RESID	M & R	R / R	OTHER
1	2380234.	929788.	2247958.	0.	0.
2	2304982.	923713.	2147047.	0.	0.
3	2227198.	915648.	2050665.	0.	0.
4	2157766.	905040.	1958611.	0.	0.
5	2086392.	889941.	1870688.	0.	0.
6	2012787.	871460.	1786713.	0.	0.
7	1920875.	854437.	1706507.	2858464.	0.
***	********	6290028.	********	3013931.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LIFE CYCLE COST ANALYSIS STUDY: PERB
LCCID 1.065 DATE/TIME: 01-29-96 15:26:47
PROJECT NO., FY, & TITLE: FY 1994 PERB25
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR B
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 24

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.57	JUL99-JUL23
ELECT DEMAND	.0	.00	JUL99-JUL23
RESIDUAL OIL	860364.7	2.96	JUL99-JUL23
MAINT LABOR	482631.0	.00	JUL99-JUL23
MAINT SUPPLY	74076.0	.00	JUL99-JUL23
SERVICE COST	2250000.0	.00	JUL99-JUL23
FW_REG	851.0	.00	JAN 17
F_FAN	39246.0	.00	JAN 13
F_FAN	17230.0	.00	JAN 17
RELVALVE	9764.0	.00	JAN 08
WTBOILER	4211724.0	.00	JAN 05
WTBURNER	382884.0	.00	JAN 05
BOILMASTER	24310.0	.00	JAN 07
DAMPACT	5348.0	.00	JAN 08
FLOWMETER	15072.0	.00	JAN 08
O2TRIM	48620.0	.00	JAN 08
TEMPREC	15072.0	.00	JAN 08
AIRCOMPRECIP	37012.0	.00	JAN 09
EMERGENCYGEN	44670.0	.00	JAN 14
FWHEATER	21697.0	.00	JAN 18
NAGPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	4376.0	.00	JAN 22
OILPIPEABOVE	5834.0	.00	JAN 22
OILPIPEABOVE	4984.0	.00	JAN 22
TANKABOVE	379239.0	.00	JAN 12
SZSOFT	261637.0	.00	JAN 06

```
LCCID  1.065                       DATE/TIME:  01-29-96  15:26:47
PROJECT NO., FY, & TITLE:            FY 1994     PERB25
INSTALLATION & LOCATION: DDRE     PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD

               BASIC INPUT DATA SUMMARY


                OTHER KEY INPUT DATA

     DOE REGION HAS NOT YET BEEN SELECTED.


ENERGY USAGE:   10**6 BTUS        ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE    $/MBTU    AMOUNT     ELECT. DEMAND  PROJECTED DATES
ELECT           17.27  164127.0                .0     JAN99-JAN24
RESID            3.32  259146.0                       JAN99-JAN24
```

```
LCCID  1.065                  DATE/TIME:  01-29-96  15:26:47
PROJECT NO., FY, & TITLE:      FY 1994     PERB25
INSTALLATION & LOCATION: DDRE     PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: TD

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                              0.

ENERGY COSTS:

ELECTRICITY                         38555660.
RESIDUAL OIL                        18118980.

TOTAL ENERGY COSTS                             56674640.

RECURRING M&R/CUSTODIAL COSTS                  34192480.

MAJOR REPAIR/REPLACEMENT COSTS                  3324316.

OTHER O&M COSTS & MONETARY BENEFITS                   0.

DISPOSAL COSTS/RETENTION VALUE                        0.

LCC OF ALL COSTS/BENEFITS (NET PW)             94191420.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

LCCID 1.065 DATE/TIME: 01-29-96 15:26:47
PROJECT NO., FY, & TITLE: FY 1994 PERB25
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQ#4OIL2005BLR
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL23

PAY	ELECT	RESID	M & R	R / R	OTHER
1	2380234.	929788.	2247958.	0.	0.
2	2304982.	923713.	2147047.	0.	0.
3	2227198.	915648.	2050665.	0.	0.
4	2157766.	905040.	1958611.	0.	0.
5	2086392.	889941.	1870688.	0.	0.
6	2012787.	871460.	1786713.	0.	0.
7	1920875.	854437.	1706507.	2858464.	0.
8	1836995.	837085.	1629901.	155466.	0.
9	1770433.	817856.	1556735.	13797.	0.
10	1696170.	796177.	1486853.	50886.	0.
11	1627572.	774919.	1420108.	19162.	0.
12	1557878.	754262.	1356359.	0.	0.
13	1489092.	731030.	1295472.	0.	0.
14	1423379.	708809.	1237318.	171069.	0.
15	1360610.	687553.	1181774.	16909.	0.
16	1300622.	666779.	1128724.	18381.	0.
17	1243150.	644082.	1078056.	0.	0.
18	1188184.	621306.	1029662.	0.	0.
19	1135732.	600373.	983440.	6483.	0.
20	1085556.	579371.	939293.	7430.	0.
21	1037651.	559709.	897128.	0.	0.
22	991832.	540013.	856856.	0.	0.
23	948086.	521561.	818392.	0.	0.
24	906244.	503099.	781654.	6269.	0.
25	866239.	484964.	746565.	0.	0.
***	********	********	********	3324316.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

```
     LIFE CYCLE COST ANALYSIS                          STUDY: PERB
LCCID  1.065                      DATE/TIME:  02-05-96  13:23:12
PROJECT NO., FY, & TITLE:          FY 1994     PERB7
INSTALLATION & LOCATION: DDRE      PENNSYLVANNIA
DESIGN FEATURE: SQNAB2005BLR C&D
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 06

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.75	JUL99-JUL05
ELECT DEMAND	.0	.00	JUL99-JUL05
NATURAL GAS	560532.0	2.91	JUL99-JUL05
MAINT LABOR	482631.0	.00	JUL99-JUL05
MAINT SUPPLY	74076.0	.00	JUL99-JUL05
SERVICE COST	2250000.0	.00	JUL99-JUL05
WTBOILER	4211724.0	.00	JAN 05
WTBURNER	382884.0	.00	JAN 05
SZSOFT	261637.0	.00	JAN 06

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	17.27	164127.0	.0	JAN99-JAN06
NAT G	2.10	266920.0		JAN99-JAN06

```
LCCID  1.065                  DATE/TIME:  02-05-96  13:23:12
PROJECT NO., FY, & TITLE:      FY 1994     PERB7
INSTALLATION & LOCATION: DDRE    PENNSYLVANNIA
DESIGN FEATURE: SQNAB2005BLR C&D
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                               0.

ENERGY COSTS:

ELECTRICITY                        15090230.
NATURAL GAS                         3737891.

TOTAL ENERGY COSTS                             18828120.

RECURRING M&R/CUSTODIAL COSTS                  13768190.

MAJOR REPAIR/REPLACEMENT COSTS                  3013931.

OTHER O&M COSTS & MONETARY BENEFITS                    0.

DISPOSAL COSTS/RETENTION VALUE                         0.

LCC OF ALL COSTS/BENEFITS (NET PW)             35610240.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

LCCID 1.065 DATE/TIME: 02-05-96 13:23:12
PROJECT NO., FY, & TITLE: FY 1994 PERB7
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQNAB2005BLR C&D
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL05

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	2380234.	548474.	2247958.	0.	0.
2	2304982.	543619.	2147047.	0.	0.
3	2227198.	537651.	2050665.	0.	0.
4	2157766.	535170.	1958611.	0.	0.
5	2086392.	532253.	1870688.	0.	0.
6	2012787.	525942.	1786713.	0.	0.
7	1920875.	514782.	1706507.	2858464.	0.
***	********	3737891.	********	3013931.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

```
     LIFE CYCLE COST ANALYSIS                              STUDY: PERB
LCCID  1.065                        DATE/TIME:  02-05-96  13:24:51
PROJECT NO., FY, & TITLE:      FY 1994     PERB25
INSTALLATION & LOCATION: DDRE     PENNSYLVANNIA
DESIGN FEATURE: SQNAG2005BLR C&D
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 24

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.57	JUL99-JUL23
ELECT DEMAND	.0	.00	JUL99-JUL23
NATURAL GAS	560532.0	2.62	JUL99-JUL23
MAINT LABOR	482631.0	.00	JUL99-JUL23
MAINT SUPPLY	74076.0	.00	JUL99-JUL23
SERVICE COST	2250000.0	.00	JUL99-JUL23
FW_REG	851.0	.00	JAN 17
F_FAN	39246.0	.00	JAN 13
F_FAN	17230.0	.00	JAN 17
RELVALVE	9764.0	.00	JAN 08
WTBOILER	4211724.0	.00	JAN 05
WTBURNER	382884.0	.00	JAN 05
BOILMASTER	24310.0	.00	JAN 07
DAMPACT	5348.0	.00	JAN 08
FLOWMETER	15072.0	.00	JAN 08
O2TRIM	48620.0	.00	JAN 08
TEMPREC	15072.0	.00	JAN 08
AIRCOMPRECIP	37012.0	.00	JAN 09
EMERGENCYGEN	44670.0	.00	JAN 14
FWHEATER	21697.0	.00	JAN 18
NAGPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	4376.0	.00	JAN 22
OILPIPEABOVE	5834.0	.00	JAN 22
OILPIPEABOVE	4984.0	.00	JAN 22
TANKABOVE	379239.0	.00	JAN 12
SZSOFT	261637.0	.00	JAN 06

```
LCCID  1.065                      DATE/TIME:  02-05-96  13:24:51
PROJECT NO., FY, & TITLE:      FY 1994     PERB25
INSTALLATION & LOCATION: DDRE     PENNSYLVANNIA
DESIGN FEATURE: SQNAG2005BLR C&D
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

BASIC INPUT DATA SUMMARY

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

```
ENERGY USAGE:  10**6 BTUS       ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE    $/MBTU    AMOUNT    ELECT. DEMAND  PROJECTED DATES
ELECT           17.27  164127.0              .0      JAN99-JAN24
NAT G            2.10  266920.0                      JAN99-JAN24
```

```
LCCID  1.065                  DATE/TIME:  02-05-96  13:24:51
PROJECT NO., FY, & TITLE:      FY 1994     PERB25
INSTALLATION & LOCATION: DDRE    PENNSYLVANNIA
DESIGN FEATURE: SQNAG2005BLR C&D
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
ELECTRICITY	38555660.	
NATURAL GAS	11161430.	
TOTAL ENERGY COSTS		49717080.
RECURRING M&R/CUSTODIAL COSTS		34192480.
MAJOR REPAIR/REPLACEMENT COSTS		3324316.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		87233870.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LCCID 1.065 DATE/TIME: 02-05-96 13:24:51
PROJECT NO., FY, & TITLE: FY 1994 PERB25
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQNAG2005BLR C&D
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL23

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	2380234.	548474.	2247958.	0.	0.
2	2304982.	543619.	2147047.	0.	0.
3	2227198.	537651.	2050665.	0.	0.
4	2157766.	535170.	1958611.	0.	0.
5	2086392.	532253.	1870688.	0.	0.
6	2012787.	525942.	1786713.	0.	0.
7	1920875.	514782.	1706507.	2858464.	0.
8	1836995.	509176.	1629901.	155466.	0.
9	1770433.	507566.	1556735.	13797.	0.
10	1696170.	501461.	1486853.	50886.	0.
11	1627572.	492814.	1420108.	19162.	0.
12	1557878.	479730.	1356359.	0.	0.
13	1489092.	463961.	1295472.	0.	0.
14	1423379.	448884.	1237318.	171069.	0.
15	1360610.	434467.	1181774.	16909.	0.
16	1300622.	420439.	1128724.	18381.	0.
17	1243150.	405491.	1078056.	0.	0.
18	1188184.	390619.	1029662.	0.	0.
19	1135732.	376859.	983440.	6483.	0.
20	1085556.	363171.	939293.	7430.	0.
21	1037651.	350312.	897128.	0.	0.
22	991832.	337533.	856856.	0.	0.
23	948086.	325522.	818392.	0.	0.
24	906244.	313597.	781654.	6269.	0.
25	866239.	301934.	746565.	0.	0.
***	********	********	********	3324316.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LIFE CYCLE COST ANALYSIS STUDY: GERA
LCCID 1.065 DATE/TIME: 01-30-96 15:36:17
PROJECT NO., FY, & TITLE: FY 1994 GERA
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR E
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 11

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.75	JUL99-JUL10
ELECT DEMAND	.0	.00	JUL99-JUL10
NATURAL GAS	621131.7	3.01	JUL99-JUL10
MAINT LABOR	482631.0	.00	JUL99-JUL10
MAINT SUPPLY	74076.0	.00	JUL99-JUL10
SERVICE COST	2250000.0	.00	JUL99-JUL10
BREECH	2425.0	.00	JAN 99
OPACMONITOR	127628.0	.00	JAN 03
STACK	53577.0	.00	JAN 09
DRUMCTL	6381.0	.00	JAN 99
DRUMCTL	6381.0	.00	JAN 99
FW_REG	2680.0	.00	JAN 99
I_FAN	45467.0	.00	JAN 99
RELVALVE	6892.0	.00	JAN 99
RELVALVE	9764.0	.00	JAN 08
WTBOILER	335024.0	.00	JAN 09
WTBURNER	95721.0	.00	JAN 09
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
BOILMASTER	24310.0	.00	JAN 07
DAMPACT	5348.0	.00	JAN 08
FLAMESAFE	48620.0	.00	JAN 02
FLOWMETER	15072.0	.00	JAN 08
O2TRIM	48620.0	.00	JAN 08
TEMPREC	15072.0	.00	JAN 08
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 09
AIRRECV	989.0	.00	JAN 99
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99

```
LCCID  1.065                     DATE/TIME:  01-30-96  15:36:17
PROJECT NO., FY, & TITLE:         FY 1994     GERA
INSTALLATION & LOCATION: DDRE       PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

BASIC INPUT DATA SUMMARY

CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 09
FEEDPUMP	48499.0	.00	JAN 99
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99
WATERSTOR	38544.0	.00	JAN 99
PORT_EXTGSHR	1884.0	.00	JAN 99
HEATER	19448.0	.00	JAN 02
PUMP	19448.0	.00	JAN 02
UNLOADPUMP	17746.0	.00	JAN 99
SZSOFT	261637.0	.00	JAN 06
DOORS	10210.0	.00	JAN 99
LIGHTS	2553.0	.00	JAN 99
ROOF	9.0	.00	JAN 99
SIDING	26.0	.00	JAN 99
SUMPPUMPSUB	7051.0	.00	JAN 99
WINDOWS	523.0	.00	JAN 99

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	17.27	164127.0	.0	JAN99-JAN11
NAT G	2.10	295777.0		JAN99-JAN11

```
LCCID  1.065                        DATE/TIME:  01-30-96  15:36:17
PROJECT NO., FY, & TITLE:      FY 1994    GERA
INSTALLATION & LOCATION: DDRE     PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
ELECTRICITY	23579280.	
NATURAL GAS	6902022.	
TOTAL ENERGY COSTS		30481300.
RECURRING M&R/CUSTODIAL COSTS		21218140.
MAJOR REPAIR/REPLACEMENT COSTS		1025614.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		52725060.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LCCID 1.065 DATE/TIME: 01-30-96 15:36:17
PROJECT NO., FY, & TITLE: FY 1994 GERA
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL10

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	2380234.	607770.	2247958.	359596.	0.
2	2304982.	602390.	2147047.	0.	0.
3	2227198.	595777.	2050665.	0.	0.
4	2157766.	593028.	1958611.	62490.	0.
5	2086392.	589796.	1870688.	87041.	0.
6	2012787.	582802.	1786713.	0.	0.
7	1920875.	570435.	1706507.	0.	0.
8	1836995.	564223.	1629901.	155466.	0.
9	1770433.	562440.	1556735.	13797.	0.
10	1696170.	555674.	1486853.	50886.	0.
11	1627572.	546092.	1420108.	296337.	0.
12	1557878.	531594.	1356359.	0.	0.
***	********	6902022.	********	1025614.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LIFE CYCLE COST ANALYSIS STUDY: GERB
LCCID 1.065 DATE/TIME: 02-05-96 13:27:01
PROJECT NO., FY, & TITLE: FY 1994 GERB12
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR E
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 11

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.75	JUL99-JUL10
ELECT DEMAND	.0	.00	JUL99-JUL10
NATURAL GAS	560532.0	3.01	JUL99-JUL10
MAINT LABOR	482631.0	.00	JUL99-JUL10
MAINT SUPPLY	74076.0	.00	JUL99-JUL10
SERVICE COST	2250000.0	.00	JUL99-JUL10
RELVALVE	9764.0	.00	JAN 08
WTBOILER	4211724.0	.00	JAN 09
WTBURNER	382884.0	.00	JAN 09
BOILMASTER	24310.0	.00	JAN 07
DAMPACT	5348.0	.00	JAN 08
FLOWMETER	15072.0	.00	JAN 08
O2TRIM	48620.0	.00	JAN 08
TEMPREC	15072.0	.00	JAN 08
AIRCOMPRECIP	37012.0	.00	JAN 09
SZSOFT	261637.0	.00	JAN 06

```
LCCID  1.065                   DATE/TIME:  02-05-96  13:27:01
PROJECT NO., FY, & TITLE:       FY 1994    PERB12
INSTALLATION & LOCATION: DDRE     PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR E
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: TD

               BASIC INPUT DATA SUMMARY


                OTHER KEY INPUT DATA

     DOE REGION HAS NOT YET BEEN SELECTED.


ENERGY USAGE:  10**6 BTUS        ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE    $/MBTU    AMOUNT    ELECT. DEMAND  PROJECTED DATES
ELECT          17.27  164127.0               .0      JAN99-JAN11
NAT G           2.10  266920.0                       JAN99-JAN11
```

```
LCCID  1.065                       DATE/TIME:  02-05-96  13:27:01
PROJECT NO., FY, & TITLE:           FY 1994    PERB12
INSTALLATION & LOCATION: DDRE      PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR E
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
ELECTRICITY	23579280.	
NATURAL GAS	6228637.	
TOTAL ENERGY COSTS		29807920.
RECURRING M&R/CUSTODIAL COSTS		21218140.
MAJOR REPAIR/REPLACEMENT COSTS		2618046.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		53644110.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LCCID 1.065 DATE/TIME: 02-05-96 13:27:01
PROJECT NO., FY, & TITLE: FY 1994 PERB12
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR E
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL10

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	2380234.	548474.	2247958.	0.	0.
2	2304982.	543619.	2147047.	0.	0.
3	2227198.	537651.	2050665.	0.	0.
4	2157766.	535170.	1958611.	0.	0.
5	2086392.	532253.	1870688.	0.	0.
6	2012787.	525942.	1786713.	0.	0.
7	1920875.	514782.	1706507.	0.	0.
8	1836995.	509176.	1629901.	155466.	0.
9	1770433.	507566.	1556735.	13797.	0.
10	1696170.	501461.	1486853.	50886.	0.
11	1627572.	492814.	1420108.	2397897.	0.
12	1557878.	479730.	1356359.	0.	0.
***	********	6228637.	********	2618046.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LIFE CYCLE COST ANALYSIS STUDY: GERB
LCCID 1.065 DATE/TIME: 02-05-96 13:28:17
PROJECT NO., FY, & TITLE: FY 1994 GERB25
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR E
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 24

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.57	JUL99-JUL23
ELECT DEMAND	.0	.00	JUL99-JUL23
NATURAL GAS	560532.0	2.62	JUL99-JUL23
MAINT LABOR	482631.0	.00	JUL99-JUL23
MAINT SUPPLY	74076.0	.00	JUL99-JUL23
SERVICE COST	2250000.0	.00	JUL99-JUL23
FW_REG	851.0	.00	JAN 17
F_FAN	39246.0	.00	JAN 13
F_FAN	17230.0	.00	JAN 17
RELVALVE	9764.0	.00	JAN 08
WTBOILER	4211724.0	.00	JAN 09
WTBURNER	382884.0	.00	JAN 09
BOILMASTER	24310.0	.00	JAN 07
DAMPACT	5348.0	.00	JAN 08
FLOWMETER	15072.0	.00	JAN 08
O2TRIM	48620.0	.00	JAN 08
TEMPREC	15072.0	.00	JAN 08
AIRCOMPRECIP	37012.0	.00	JAN 09
EMERGENCYGEN	44670.0	.00	JAN 14
FWHEATER	21697.0	.00	JAN 18
NAGPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	4376.0	.00	JAN 22
OILPIPEABOVE	5834.0	.00	JAN 22
OILPIPEABOVE	4984.0	.00	JAN 22

TANKABOVE	379239.0	.00	JAN 12
SZSOFT	261637.0	.00	JAN 06

```
   LIFE CYCLE COST ANALYSIS                          STUDY: GERB
LCCID  1.065                   DATE/TIME:  02-05-96  13:28:17
PROJECT NO., FY, & TITLE:       FY 1994     GERB25
INSTALLATION & LOCATION: DDRE      PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR E
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: TD
```

BASIC INPUT DATA SUMMARY

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

ENERGY USAGE:	10**6 BTUS		ELECTRIC DEMAND:	10**0 DOLLARS
ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	17.27	164127.0	.0	JAN99-JAN24
NAT G	2.10	266920.0		JAN99-JAN24

```
    LIFE CYCLE COST ANALYSIS                              STUDY: GERB
LCCID  1.065                  DATE/TIME:  02-05-96  13:28:17
PROJECT NO., FY, & TITLE:      FY 1994    GERB25
INSTALLATION & LOCATION: DDRE     PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR E
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: TD

                 LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                                   0.

ENERGY COSTS:

ELECTRICITY                          38555660.
NATURAL GAS                          11161430.

TOTAL ENERGY COSTS                                  49717080.

RECURRING M&R/CUSTODIAL COSTS                       34192480.

MAJOR REPAIR/REPLACEMENT COSTS                       2844587.

OTHER O&M COSTS & MONETARY BENEFITS                        0.

DISPOSAL COSTS/RETENTION VALUE                             0.

LCC OF ALL COSTS/BENEFITS (NET PW)                  86754140.


*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

LIFE CYCLE COST ANALYSIS STUDY: GERB
LCCID 1.065 DATE/TIME: 02-05-96 13:28:17
PROJECT NO., FY, & TITLE: FY 1994 GERB25
INSTALLATION & LOCATION: DDRE PENNSYLVANNIA
DESIGN FEATURE: SQNAG2009BLR E
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: TD

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL23

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	2380234.	548474.	2247958.	0.	0.
2	2304982.	543619.	2147047.	0.	0.
3	2227198.	537651.	2050665.	0.	0.
4	2157766.	535170.	1958611.	0.	0.
5	2086392.	532253.	1870688.	0.	0.
6	2012787.	525942.	1786713.	0.	0.
7	1920875.	514782.	1706507.	0.	0.
8	1836995.	509176.	1629901.	155466.	0.
9	1770433.	507566.	1556735.	13797.	0.
10	1696170.	501461.	1486853.	50886.	0.
11	1627572.	492814.	1420108.	2397897.	0.
12	1557878.	479730.	1356359.	0.	0.
13	1489092.	463961.	1295472.	0.	0.
14	1423379.	448884.	1237318.	171069.	0.
15	1360610.	434467.	1181774.	16909.	0.
16	1300622.	420439.	1128724.	18381.	0.
17	1243150.	405491.	1078056.	0.	0.
18	1188184.	390619.	1029662.	0.	0.
19	1135732.	376859.	983440.	6483.	0.
20	1085556.	363171.	939293.	7430.	0.
21	1037651.	350312.	897128.	0.	0.
22	991832.	337533.	856856.	0.	0.
23	948086.	325522.	818392.	0.	0.
24	906244.	313597.	781654.	6269.	0.
25	866239.	301934.	746565.	0.	0.
***	********	********	********	2844587.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LIFE CYCLE COST ANALYSIS STUDY: DLT1
LCCID 1.065 DATE/TIME: 02-05-96 13:47:01
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANIA
DESIGN FEATURE: ALT 1-GAS PRICE CHANGE
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: SCI

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 24

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	6221000.0	.00	JUN 97
ELECTRICITY	2834473.0	.57	JUL99-JUL23
ELECT DEMAND	.0	.00	JUL99-JUL23
NATURAL GAS	560532.0	2.62	JUL99-JUL23
MAINT LABOR	482631.0	.00	JUL99-JUL23
MAINT SUPPLY	74076.0	.00	JUL99-JUL23
SERVICE COST	2250000.0	.00	JUL99-JUL23
OPACMONITOR	127628.0	.00	JAN 03
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 09
AIRRECV	989.0	.00	JAN 99
EMERGENCYGEN	44670.0	.00	JAN 14
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99
CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 99
FEEDPUMP	48499.0	.00	JAN 99
FWHEATER	21697.0	.00	JAN 18
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99
WATERSTOR	38544.0	.00	JAN 99
PORT EXTGSHR	1884.0	.00	JAN 99

HEATER	19448.0	.00	JAN 02
NAGPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	4376.0	.00	JAN 22
OILPIPEABOVE	5834.0	.00	JAN 22

```
     LIFE CYCLE COST ANALYSIS                          STUDY: DLT1
LCCID  1.065                        DATE/TIME:  02-05-96  13:47:01
PROJECT NO., FY, & TITLE: 12172    FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL    PENNSYLVANIA
DESIGN FEATURE: ALT 1-GAS PRICE CHANGE
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

OILPIPEABOVE	4984.0	.00	JAN 22
PUMP	19448.0	.00	JAN 02
TANKABOVE	379239.0	.00	JAN 12
UNLOADPUMP	17746.0	.00	JAN 99
SZSOFT	261637.0	.00	JAN 06
DOORS	10210.0	.00	JAN 99
LIGHTS	2553.0	.00	JAN 99
ROOF	9.0	.00	JAN 99
SIDING	26.0	.00	JAN 99
SUMPPUMPSUB	7051.0	.00	JAN 99
WINDOWS	523.0	.00	JAN 99

OTHER KEY INPUT DATA

```
     LOCATION  - PENNSYLVANIA           CENSUS REGION:  1
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90

ENERGY USAGE:  10**6 BTUS        ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE   $/MBTU   AMOUNT     ELECT. DEMAND  PROJECTED DATES
ELECT          17.27  164127.0              .0      JAN99-JAN24
NAT G           2.10  266920.0                      JAN99-JAN24
```

LIFE CYCLE COST ANALYSIS STUDY: DLT1
LCCID 1.065 DATE/TIME: 02-05-96 13:47:01
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANIA
DESIGN FEATURE: ALT 1-GAS PRICE CHANGE
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: SCI

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		5482856.
ENERGY COSTS:		
ELECTRICITY	38555660.	
NATURAL GAS	11161430.	
TOTAL ENERGY COSTS		49717080.
RECURRING M&R/CUSTODIAL COSTS		34192480.
MAJOR REPAIR/REPLACEMENT COSTS		836474.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		90228900.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

Computed by · C. Realy 29 Sept 94
Check by 9-30-94

LIFE CYCLE COST ANALYSIS STUDY: PER1
LCCID 1.065 DATE/TIME: 09-28-94 08:48:41
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: PERIOD A
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: SCI

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 04

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 97
ELECTRICITY	2834473.0	.75	JUL99-JUL03
ELECT DEMAND	.0	.00	JUL99-JUL03
RESIDUAL OIL	953377.8	3.75	JUL99-JUL03
MAINT LABOR	482631.0	.00	JUL99-JUL03
MAINT SUPPLY	74076.0	.00	JUL99-JUL03
SERVICE COST	2250000.0	.00	JUL99-JUL03
BREECH	2425.0	.00	JAN 99
OPACMONITOR	127628.0	.00	JAN 03
STACK	53577.0	.00	JAN 99
DRUMCTL	6381.0	.00	JAN 99
DRUMCTL	6381.0	.00	JAN 99
FTBOILER	335024.0	.00	JAN 02
FTBURNER	95721.0	.00	JAN 02
FW_REG	2680.0	.00	JAN 99
I_FAN	45467.0	.00	JAN 99
RELVALVE	6892.0	.00	JAN 99
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
FLAMESAFE	48620.0	.00	JAN 02
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRRECV	989.0	.00	JAN 99
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99
CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 99
FEEDPUMP	48499.0	.00	JAN 99
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99

```
LCCID  1.065                  DATE/TIME:  09-28-94  08:48:41
PROJECT NO., FY, & TITLE: 12172   FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL    PENNSYLVANNIA
DESIGN FEATURE: PERIOD A
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

WATERSTOR	.38544.0	.00	JAN 99
PORT_EXTGSHR	1884.0	.00	JAN 99
HEATER	19448.0	.00	JAN 02
PUMP	19448.0	.00	JAN 02
UNLOADPUMP	17746.0	.00	JAN 99
DOORS	10210.0	.00	JAN 99
LIGHTS	2553.0	.00	JAN 99
ROOF	9.0	.00	JAN 99
SIDING	26.0	.00	JAN 99
SUMPPUMPSUB	7051.0	.00	JAN 99
WINDOWS	523.0	.00	JAN 99

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

```
ENERGY USAGE:  10**6 BTUS        ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE    $/MBTU    AMOUNT    ELECT. DEMAND  PROJECTED DATES
ELECT           17.27  164127.0              .0      JAN99-JAN04
RESID            3.32  287162.0                      JAN99-JAN04
```

LCCID 1.065 DATE/TIME: 09-28-94 08:48:41
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: PERIOD A
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: SCI

LIFE CYCLE COST TOTALS*

		Period A	Period B	Total
INITIAL INVESTMENT COSTS		0.		
ENERGY COSTS:				
ELECTRICITY	11156570.		27399090	38555660
RESIDUAL OIL	5057553.		15200770	20258323
TOTAL ENERGY COSTS		16214120.	42599860	58,813,983
RECURRING M&R/CUSTODIAL COSTS		10274970.	23917510	34,192,480
MAJOR REPAIR/REPLACEMENT COSTS		902444.	3458664	4,361,108
OTHER O&M COSTS & MONETARY BENEFITS		0.		
DISPOSAL COSTS/RETENTION VALUE		0.		
LCC OF ALL COSTS/BENEFITS (NET PW)		27391540.	69,976,030	97,367,570

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LCCID 1.065 DATE/TIME: 09-28-94 08:48:41
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: PERIOD A
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: SCI

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL03

PAY	ELECT	RESID	M & R	R / R	OTHER
1	2380234.	1030306.	2247958.	445342.	0.
2	2304982.	1023575.	2147047.	0.	0.
3	2227198.	1014637.	2050665.	0.	0.
4	2157766.	1002883.	1958611.	370061.	0.
5	2086392.	986152.	1870688.	87041.	0.
***	********	5057553.	********	902444.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

Computed by: C. Radloff 29 Sept 94

LIFE CYCLE COST ANALYSIS STUDY: PER2
LCCID 1.065 DATE/TIME: 09-29-94 07:44:54
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: PERIOD B
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: SCI

9-30-94

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JAN 03
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 04
ANALYSIS END DATE (AED)	JAN 24

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JAN 03
ELECTRICITY	2834473.0	.57	JUL04-JUL23
ELECT DEMAND	.0	.00	JUL04-JUL23
DISTILLATE OIL	1119511.0	2.09	JUL04-JUL23
MAINT LABOR	482631.0	.00	JUL04-JUL23
MAINT SUPPLY	74076.0	.00	JUL04-JUL23
SERVICE COST	2250000.0	.00	JUL04-JUL23
FW_REG	851.0	.00	JAN 17
F_FAN	39246.0	.00	JAN 13
F_FAN	17230.0	.00	JAN 17
RELVALVE	9764.0	.00	JAN 08
WTBOILER	4211724.0	.00	JAN 04
WTBURNER	382884.0	.00	JAN 04
BOILMASTER	24310.0	.00	JAN 07
DAMPACT	5348.0	.00	JAN 08
FLOWMETER	15072.0	.00	JAN 08
O2TRIM	48620.0	.00	JAN 08
TEMPREC	15072.0	.00	JAN 08
AIRCOMPRECIP	37012.0	.00	JAN 09
EMERGENCYGEN	44670.0	.00	JAN 14
FWHEATER	21697.0	.00	JAN 18
NAGPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	4376.0	.00	JAN 22
OILPIPEABOVE	5834.0	.00	JAN 22
OILPIPEABOVE	4984.0	.00	JAN 22
TANKABOVE	379239.0	.00	JAN 12
SZSOFT	261637.0	.00	JAN 06

```
LCCID  1.065                      DATE/TIME:  09-29-94  07:44:54
PROJECT NO., FY, & TITLE: 12172   FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL    PENNSYLVANNIA
DESIGN FEATURE: PERIOD B
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: SCI

               BASIC INPUT DATA SUMMARY


                OTHER KEY INPUT DATA

     DOE REGION HAS NOT YET BEEN SELECTED.


ENERGY USAGE:  10**6 BTUS        ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE    $/MBTU    AMOUNT    ELECT. DEMAND  PROJECTED DATES
ELECT           17.27  164127.0              .0      JAN04-JAN24
DIST             4.32  259146.0                      JAN04-JAN24
```

```
LCCID  1.065                     DATE/TIME:  09-29-94  07:44:54
PROJECT NO., FY, & TITLE: 12172   FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL     PENNSYLVANNIA
DESIGN FEATURE: PERIOD B
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: SCI

                    LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                                      0.

ENERGY COSTS:

ELECTRICITY                           27399090.
DISTILLATE OIL                        15200770.

TOTAL ENERGY COSTS                                     42599860.

RECURRING M&R/CUSTODIAL COSTS                          23917510.

MAJOR REPAIR/REPLACEMENT COSTS                          3458664.

OTHER O&M COSTS & MONETARY BENEFITS                           0.

DISPOSAL COSTS/RETENTION VALUE                                0.

LCC OF ALL COSTS/BENEFITS (NET PW)                     69976030.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

LCCID 1.065 DATE/TIME: 09-29-94 07:44:54
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: PERIOD B
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER: SCI

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN04
ANNUAL PAYMENTS OCCUR: JUL04 THROUGH JUL23

PAY	ELECT	DIST	M & R	R / R	OTHER
1	2012787.	998659.	1786713.	2992812.	0.
2	1920875.	976485.	1706507.	0.	0.
3	1836995.	953353.	1629902.	155466.	0.
4	1770433.	928776.	1556735.	13797.	0.
5	1696170.	907085.	1486853.	50886.	0.
6	1627572.	880756.	1420108.	19162.	0.
7	1557878.	853242.	1356359.	0.	0.
8	1489092.	824004.	1295472.	0.	0.
9	1423379.	796056.	1237318.	171069.	0.
10	1360610.	769335.	1181775.	16909.	0.
11	1300622.	743408.	1128724.	18381.	0.
12	1243151.	716207.	1078056.	0.	0.
13	1188184.	689293.	1029662.	0.	0.
14	1135732.	664286.	983440.	6483.	0.
15	1085556.	639543.	939293.	7430.	0.
16	1037651.	616249.	897128.	0.	0.
17	991832.	593217.	856856.	0.	0.
18	948086.	571527.	818392.	0.	0.
19	906244.	550095.	781654.	6269.	0.
20	866239.	529197.	746565.	0.	0.
***	********	********	********	3458664.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

Computed CM Radloff 9-8-94
Checked / K. Cannon(?) 9-9-92

LIFE CYCLE COST ANALYSIS STUDY: ALT1
LCCID 1.065 DATE/TIME: 09-08-94 13:08:09
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: ALT 1-GAS PRICE SAME AS NO. 2
ALT. ID. A;
NAME OF DESIGNER: SCI

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 24

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	6221000.0	.00	JUN 97
ELECTRICITY	2834473.0	.57	JUL99-JUL23
ELECT DEMAND	.0	.00	JUL99-JUL23
NATURAL GAS	1119511.0	2.62	JUL99-JUL23
MAINT LABOR	482631.0	.00	JUL99-JUL23
MAINT SUPPLY	74076.0	.00	JUL99-JUL23
SERVICE COST	2250000.0	.00	JUL99-JUL23
OPACMONITOR	127628.0	.00	JAN 03
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 09
AIRRECV	989.0	.00	JAN 99
EMERGENCYGEN	44670.0	.00	JAN 14
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99
CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 99
FEEDPUMP	48499.0	.00	JAN 99
FWHEATER	21697.0	.00	JAN 18
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99
WATERSTOR	38544.0	.00	JAN 99
PORT_EXTGSHR	1884.0	.00	JAN 99
HEATER	19448.0	.00	JAN 02
NAGPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	4376.0	.00	JAN 22
OILPIPEABOVE	5834.0	.00	JAN 22

```
LCCID  1.065                    DATE/TIME:  09-08-94  13:08:09
PROJECT NO., FY, & TITLE: 12172   FY 1994   CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL     PENNSYLVANNIA
DESIGN FEATURE: ALT 1-GAS PRICE SAME AS NO. 2
ALT. ID. A;
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

OILPIPEABOVE	4984.0	.00	JAN 22
PUMP	19448.0	.00	JAN 02
TANKABOVE	379239.0	.00	JAN 12
UNLOADPUMP	17746.0	.00	JAN 99
SZSOFT	261637.0	.00	JAN 06
DOORS	10210.0	.00	JAN 99
LIGHTS	2553.0	.00	JAN 99
ROOF	9.0	.00	JAN 99
SIDING	26.0	.00	JAN 99
SUMPPUMPSUB	7051.0	.00	JAN 99
WINDOWS	523.0	.00	JAN 99

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	17.27	164127.0	.0	JAN99-JAN24
NAT G	4.32	259146.0		JAN99-JAN24

```
LCCID  1.065                DATE/TIME:  09-08-94  13:08:09
PROJECT NO., FY, & TITLE: 12172   FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL    PENNSYLVANNIA
DESIGN FEATURE: ALT 1-GAS PRICE SAME AS NO. 2
ALT. ID. A;
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                            5482856.

ENERGY COSTS:

ELECTRICITY                             38555660.
NATURAL GAS                             22291920.

TOTAL ENERGY COSTS                                 60847580.

RECURRING M&R/CUSTODIAL COSTS                      34192480.

MAJOR REPAIR/REPLACEMENT COSTS                       836474.

OTHER O&M COSTS & MONETARY BENEFITS                       0.

DISPOSAL COSTS/RETENTION VALUE                            0.

LCC OF ALL COSTS/BENEFITS (NET PW)                101359400.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

LCCID 1.065 DATE/TIME: 09-08-94 13:08:09
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: ALT 1-GAS PRICE SAME AS NO. 2
ALT. ID. A;
NAME OF DESIGNER: SCI

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL23

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	2380234.	1095428.	2247958.	343882.	0.
2	2304982.	1085732.	2147047.	0.	0.
3	2227198.	1073813.	2050665.	0.	0.
4	2157766.	1068857.	1958611.	27773.	0.
5	2086392.	1063032.	1870688.	87041.	0.
6	2012787.	1050426.	1786713.	0.	0.
7	1920875.	1028137.	1706507.	0.	0.
8	1836995.	1016940.	1629901.	155466.	0.
9	1770433.	1013726.	1556735.	0.	0.
10	1696170.	1001532.	1486853.	0.	0.
11	1627572.	984262.	1420108.	19162.	0.
12	1557878.	958131.	1356359.	0.	0.
13	1489092.	926637.	1295472.	0.	0.
14	1423379.	896524.	1237318.	171069.	0.
15	1360610.	867729.	1181774.	0.	0.
16	1300622.	839713.	1128724.	18381.	0.
17	1243150.	809859.	1078056.	0.	0.
18	1188184.	780156.	1029662.	0.	0.
19	1135732.	752675.	983440.	0.	0.
20	1085556.	725336.	939293.	7430.	0.
21	1037651.	699654.	897128.	0.	0.
22	991832.	674130.	856856.	0.	0.
23	948086.	650143.	818392.	0.	0.
24	906244.	626324.	781654.	6269.	0.
25	866239.	603031.	746565.	0.	0.
***	********	********	********	836474.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

Computed CM Rudloff 9-8-94
Checked [illegible] 9-7-94

LIFE CYCLE COST ANALYSIS STUDY: ALT2
LCCID 1.065 DATE/TIME: 09-08-94 13:12:27
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: ALT 2-G/O BOIL W/COGEN & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 24

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	16161000.0	.00	JUN 97
ELECTRICITY	1475276.0	.57	JUL99-JUL23
ELECT DEMAND	.0	.00	JUL99-JUL23
NATURAL GAS	2435469.0	2.62	JUL99-JUL23
MAINT LABOR	532631.0	.00	JUL99-JUL23
MAINT SUPPLY	124076.0	.00	JUL99-JUL23
SERVICE COST	2250000.0	.00	JUL99-JUL23
OPACMONITOR	127628.0	.00	JAN 03
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 09
AIRRECV	989.0	.00	JAN 99
EMERGENCYGEN	44670.0	.00	JAN 14
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99
CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 99
FEEDPUMP	48499.0	.00	JAN 99
FWHEATER	21697.0	.00	JAN 18
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99
WATERSTOR	38544.0	.00	JAN 99
PORT_EXTGSHR	1884.0	.00	JAN 99
HEATER	19448.0	.00	JAN 02
NAGPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	4376.0	.00	JAN 22
OILPIPEABOVE	5834.0	.00	JAN 22

LCCID 1.065 DATE/TIME: 09-08-94 13:12:27
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: ALT 2-G/O BOIL W/COGEN & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI

BASIC INPUT DATA SUMMARY

OILPIPEABOVE	4984.0	.00	JAN 22
PUMP	19448.0	.00	JAN 02
TANKABOVE	379239.0	.00	JAN 12
UNLOADPUMP	17746.0	.00	JAN 99
SZSOFT	261637.0	.00	JAN 06
DOORS	10210.0	.00	JAN 99
LIGHTS	2553.0	.00	JAN 99
ROOF	9.0	.00	JAN 99
SIDING	26.0	.00	JAN 99
SUMPPUMPSUB	7051.0	.00	JAN 99
WINDOWS	523.0	.00	JAN 99

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	21.03	70151.0	.0	JAN99-JAN24
NAT G	4.32	563766.0		JAN99-JAN24

LCCID 1.065 DATE/TIME: 09-08-94 13:12:27
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: ALT 2-G/O BOIL W/COGEN & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		14243440.
ENERGY COSTS:		
ELECTRICITY	20067300.	
NATURAL GAS	48495560.	
TOTAL ENERGY COSTS		68562850.
RECURRING M&R/CUSTODIAL COSTS		35410720.
MAJOR REPAIR/REPLACEMENT COSTS		836474.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		119053500.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LCCID 1.065 DATE/TIME: 09-08-94 13:12:27
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: ALT 2-G/O BOIL W/COGEN & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL23

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	1238855.	2383077.	2328050.	343882.	0.
2	1199688.	2361985.	2223544.	0.	0.
3	1159203.	2336054.	2123728.	0.	0.
4	1123066.	2325274.	2028394.	27773.	0.
5	1085917.	2312601.	1937339.	87041.	0.
6	1047607.	2285176.	1850371.	0.	0.
7	999769.	2236687.	1767308.	0.	0.
8	956112.	2212329.	1687973.	155466.	0.
9	921468.	2205337.	1612200.	0.	0.
10	882816.	2178808.	1539828.	0.	0.
11	847112.	2141239.	1470705.	19162.	0.
12	810838.	2084392.	1404685.	0.	0.
13	775037.	2015877.	1341628.	0.	0.
14	740835.	1950368.	1281402.	171069.	0.
15	708165.	1887725.	1223880.	0.	0.
16	676943.	1826776.	1168940.	18381.	0.
17	647030.	1761830.	1116466.	0.	0.
18	618421.	1697210.	1066347.	0.	0.
19	591121.	1637426.	1018479.	0.	0.
20	565006.	1577951.	972759.	7430.	0.
21	540073.	1522081.	929092.	0.	0.
22	516225.	1466553.	887385.	0.	0.
23	493456.	1414370.	847550.	0.	0.
24	471678.	1362554.	809503.	6269.	0.
25	450856.	1311879.	773165.	0.	0.
***	********	********	********	836474.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

Computed CMRadloff 9-8-94
Checked [illegible] 9-9-94

LIFE CYCLE COST ANALYSIS STUDY: ALT3
LCCID 1.065 DATE/TIME: 09-08-94 13:16:41
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: ALT 3-G/O BOIL W/TURB & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 24

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	13712000.0	.00	JUN 97
ELECTRICITY	2377433.0	.57	JUL99-JUL23
ELECT DEMAND	.0	.00	JUL99-JUL23
NATURAL GAS	1647709.0	2.62	JUL99-JUL23
MAINT LABOR	507631.0	.00	JUL99-JUL23
MAINT SUPPLY	99076.0	.00	JUL99-JUL23
SERVICE COST	2250000.0	.00	JUL99-JUL23
OPACMONITOR	127628.0	.00	JAN 03
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 09
AIRRECV	989.0	.00	JAN 99
EMERGENCYGEN	44670.0	.00	JAN 14
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99
CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 99
FEEDPUMP	48499.0	.00	JAN 99
FWHEATER	21697.0	.00	JAN 18
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99
WATERSTOR	38544.0	.00	JAN 99
PORT_EXTGSHR	1884.0	.00	JAN 99
HEATER	19448.0	.00	JAN 02
NAGPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	4376.0	.00	JAN 22
OILPIPEABOVE	5834.0	.00	JAN 22

```
LCCID  1.065                  DATE/TIME:  09-08-94  13:16:41
PROJECT NO., FY, & TITLE: 12172   FY 1994   CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL    PENNSYLVANNIA
DESIGN FEATURE: ALT 3-G/O BOIL W/TURB & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

OILPIPEABOVE	4984.0	.00	JAN 22
PUMP	19448.0	.00	JAN 02
TANKABOVE	379239.0	.00	JAN 12
UNLOADPUMP	17746.0	.00	JAN 99
SZSOFT	261637.0	.00	JAN 06
DOORS	10210.0	.00	JAN 99
LIGHTS	2553.0	.00	JAN 99
ROOF	9.0	.00	JAN 99
SIDING	26.0	.00	JAN 99
SUMPPUMPSUB	7051.0	.00	JAN 99
WINDOWS	523.0	.00	JAN 99

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	18.02	131933.0	.0	JAN99-JAN24
NAT G	4.32	381414.0		JAN99-JAN24

```
LCCID  1.065                  DATE/TIME:  09-08-94  13:16:41
PROJECT NO., FY, & TITLE: 12172   FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL    PENNSYLVANNIA
DESIGN FEATURE: ALT 3-G/O BOIL W/TURB & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI
```

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		12085020.
ENERGY COSTS:		
ELECTRICITY	32338810.	
NATURAL GAS	32809510.	
TOTAL ENERGY COSTS		65148310.
RECURRING M&R/CUSTODIAL COSTS		34801590.
MAJOR REPAIR/REPLACEMENT COSTS		836474.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		112871400.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LCCID 1.065 DATE/TIME: 09-08-94 13:16:41
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: ALT 3-G/O BOIL W/TURB & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL23

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	1996437.	1612263.	2288004.	343882.	0.
2	1933318.	1597993.	2185295.	0.	0.
3	1868076.	1580449.	2087197.	0.	0.
4	1809840.	1573156.	1993502.	27773.	0.
5	1749975.	1564583.	1904013.	87041.	0.
6	1688238.	1546028.	1818542.	0.	0.
7	1611146.	1513223.	1736907.	0.	0.
8	1540791.	1496744.	1658937.	155466.	0.
9	1484962.	1492013.	1584467.	0.	0.
10	1422674.	1474065.	1513340.	0.	0.
11	1365137.	1448648.	1445406.	19162.	0.
12	1306680.	1410189.	1380522.	0.	0.
13	1248985.	1363835.	1318550.	0.	0.
14	1193868.	1319515.	1259360.	171069.	0.
15	1141220.	1277134.	1202827.	0.	0.
16	1090905.	1235899.	1148832.	18381.	0.
17	1042700.	1191960.	1097261.	0.	0.
18	996597.	1148242.	1048005.	0.	0.
19	952602.	1107795.	1000959.	0.	0.
20	910517.	1067557.	956026.	7430.	0.
21	870337.	1029759.	913110.	0.	0.
22	831905.	992192.	872120.	0.	0.
23	795213.	956888.	832971.	0.	0.
24	760118.	921831.	795579.	6269.	0.
25	726563.	887548.	759865.	0.	0.
***	********	********	********	836474.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

Computed C M Radloff 9-8-94

9-9-94

```
        LIFE CYCLE COST ANALYSIS                          STUDY: AL4A
LCCID  1.065                         DATE/TIME:  09-08-94  13:22:12
PROJECT NO., FY, & TITLE: 12172     FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL     PENNSYLVANNIA
DESIGN FEATURE: ALT 4A-G/O BOIL W/WASTE WOOD
ALT. ID. A;
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 24

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	16234000.0	.00	JUN 97
ELECTRICITY	2834473.0	.57	JUL99-JUL23
ELECT DEMAND	.0	.00	JUL99-JUL23
NATURAL GAS	961463.6	2.62	JUL99-JUL23
MAINT LABOR	622631.0	.00	JUL99-JUL23
MAINT SUPPLY	124076.0	.00	JUL99-JUL23
SERVICE COST	194710.0	.00	JUL99-JUL23
OPACMONITOR	127628.0	.00	JAN 03
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 09
AIRRECV	989.0	.00	JAN 99
EMERGENCYGEN	44670.0	.00	JAN 14
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99
CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 99
FEEDPUMP	48499.0	.00	JAN 99
FWHEATER	21697.0	.00	JAN 18
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99
WATERSTOR	38544.0	.00	JAN 99
PORT_EXTGSHR	1884.0	.00	JAN 99
HEATER	19448.0	.00	JAN 02
NAGPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	4376.0	.00	JAN 22
OILPIPEABOVE	5834.0	.00	JAN 22

LCCID 1.065 DATE/TIME: 09-08-94 13:22:12
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: ALT 4A-G/O BOIL W/WASTE WOOD
ALT. ID. A;
NAME OF DESIGNER: SCI

BASIC INPUT DATA SUMMARY

OILPIPEABOVE	4984.0	.00	JAN 22
PUMP	19448.0	.00	JAN 02
TANKABOVE	379239.0	.00	JAN 12
UNLOADPUMP	17746.0	.00	JAN 99
SZSOFT	261637.0	.00	JAN 06
DOORS	10210.0	.00	JAN 99
LIGHTS	2553.0	.00	JAN 99
ROOF	9.0	.00	JAN 99
SIDING	26.0	.00	JAN 99
SUMPPUMPSUB	7051.0	.00	JAN 99
WINDOWS	523.0	.00	JAN 99

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	17.27	164127.0	.0	JAN99-JAN24
NAT G	4.32	222561.0		JAN99-JAN24

```
LCCID  1.065                 DATE/TIME:  09-08-94  13:22:12
PROJECT NO., FY, & TITLE: 12172   FY 1994   CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL    PENNSYLVANNIA
DESIGN FEATURE: ALT 4A-G/O BOIL W/WASTE WOOD
ALT. ID. A;
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                          14307780.

ENERGY COSTS:

ELECTRICITY                            38555660.
NATURAL GAS                            19144860.

TOTAL ENERGY COSTS                                57700520.

RECURRING M&R/CUSTODIAL COSTS                     11468730.

MAJOR REPAIR/REPLACEMENT COSTS                      836474.

OTHER O&M COSTS & MONETARY BENEFITS                     0.

DISPOSAL COSTS/RETENTION VALUE                          0.

LCC OF ALL COSTS/BENEFITS (NET PW)                84313500.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

```
LCCID  1.065                      DATE/TIME:  09-08-94  13:22:12
PROJECT NO., FY, & TITLE: 12172   FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL     PENNSYLVANNIA
DESIGN FEATURE: ALT 4A-G/O BOIL W/WASTE WOOD
ALT. ID. A;
NAME OF DESIGNER: SCI
```

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL23

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	2380234.	940780.	754003.	343882.	0.
2	2304982.	932454.	720156.	0.	0.
3	2227198.	922217.	687828.	0.	0.
4	2157766.	917961.	656951.	27773.	0.
5	2086392.	912958.	627460.	87041.	0.
6	2012787.	902132.	599294.	0.	0.
7	1920875.	882989.	572391.	0.	0.
8	1836995.	873373.	546697.	155466.	0.
9	1770433.	870613.	522155.	0.	0.
10	1696170.	860140.	498716.	0.	0.
11	1627572.	845308.	476328.	19162.	0.
12	1557878.	822867.	454946.	0.	0.
13	1489092.	795819.	434523.	0.	0.
14	1423379.	769957.	415017.	171069.	0.
15	1360610.	745227.	396387.	0.	0.
16	1300622.	721167.	378593.	18381.	0.
17	1243150.	695527.	361598.	0.	0.
18	1188184.	670017.	345366.	0.	0.
19	1135732.	646416.	329862.	0.	0.
20	1085556.	622936.	315055.	7430.	0.
21	1037651.	600880.	300912.	0.	0.
22	991832.	578959.	287404.	0.	0.
23	948086.	558359.	274502.	0.	0.
24	906244.	537903.	262180.	6269.	0.
25	866239.	517898.	250411.	0.	0.
***	********	********	********	836474.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

Computed C. M. Radloff 9-8-94
Checked [illegible] 9-9-94

```
     LIFE CYCLE COST ANALYSIS                          STUDY: AL4B
LCCID  1.065                   DATE/TIME:  09-08-94  13:25:58
PROJECT NO., FY, & TITLE: 12172   FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL     PENNSYLVANNIA
DESIGN FEATURE: ALT 4B-G/O BOIL W/WOOD & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	SEP 94
MIDPOINT OF CONSTRUCTION (MPC)	JUN 97
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 99
ANALYSIS END DATE (AED)	JAN 24

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	17983000.0	.00	JUN 97
ELECTRICITY	2746531.0	.57	JUL99-JUL23
ELECT DEMAND	.0	.00	JUL99-JUL23
NATURAL GAS	972311.1	2.62	JUL99-JUL23
MAINT LABOR	622631.0	.00	JUL99-JUL23
MAINT SUPPLY	124076.0	.00	JUL99-JUL23
SERVICE COST	194710.0	.00	JUL99-JUL23
OPACMONITOR	127628.0	.00	JAN 03
PUMPSIMPLEX	19144.0	.00	JAN 99
TANKPOLY	1276.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 99
AIRCOMPRECIP	37012.0	.00	JAN 09
AIRRECV	989.0	.00	JAN 99
EMERGENCYGEN	44670.0	.00	JAN 14
MOTORCTRL	65090.0	.00	JAN 99
SWITCH	18719.0	.00	JAN 99
CONDPUMP	12763.0	.00	JAN 99
CONDREC	18889.0	.00	JAN 99
DAIRHEATER	51051.0	.00	JAN 99
FEEDPUMP	48499.0	.00	JAN 99
FWHEATER	21697.0	.00	JAN 18
FWPIPINGVAL	15737.0	.00	JAN 99
FWPIPINGVAL	39131.0	.00	JAN 99
TREATPUMP	12763.0	.00	JAN 99
WATERSTOR	38544.0	.00	JAN 99
PORT_EXTGSHR	1884.0	.00	JAN 99
HEATER	19448.0	.00	JAN 02
NAGPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	3403.0	.00	JAN 22
OILPIPEABOVE	4376.0	.00	JAN 22
OILPIPEABOVE	5834.0	.00	JAN 22

```
LCCID  1.065                    DATE/TIME:  09-08-94  13:25:58
PROJECT NO., FY, & TITLE: 12172    FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL    PENNSYLVANNIA
DESIGN FEATURE: ALT 4B-G/O BOIL W/WOOD & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

OILPIPEABOVE	4984.0	.00	JAN 22
PUMP	19448.0	.00	JAN 02
TANKABOVE	379239.0	.00	JAN 12
UNLOADPUMP	17746.0	.00	JAN 99
SZSOFT	261637.0	.00	JAN 06
DOORS	10210.0	.00	JAN 99
LIGHTS	2553.0	.00	JAN 99
ROOF	9.0	.00	JAN 99
SIDING	26.0	.00	JAN 99
SUMPPUMPSUB	7051.0	.00	JAN 99
WINDOWS	523.0	.00	JAN 99

OTHER KEY INPUT DATA

DOE REGION HAS NOT YET BEEN SELECTED.

```
ENERGY USAGE:  10**6 BTUS        ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE   $/MBTU    AMOUNT     ELECT. DEMAND  PROJECTED DATES
ELECT          17.23  159404.0                .0     JAN99-JAN24
NAT G           4.32  225072.0                       JAN99-JAN24
```

```
LCCID  1.065                  DATE/TIME:  09-08-94  13:25:58
PROJECT NO., FY, & TITLE: 12172   FY 1994    CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL    PENNSYLVANNIA
DESIGN FEATURE: ALT 4B-G/O BOIL W/WOOD & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                          15849250.

ENERGY COSTS:

ELECTRICITY                            37359430.
NATURAL GAS                            19360860.

TOTAL ENERGY COSTS                                56720280.

RECURRING M&R/CUSTODIAL COSTS                     11468730.

MAJOR REPAIR/REPLACEMENT COSTS                      836474.

OTHER O&M COSTS & MONETARY BENEFITS                      0.

DISPOSAL COSTS/RETENTION VALUE                           0.

LCC OF ALL COSTS/BENEFITS (NET PW)                84874740.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

LCCID 1.065 DATE/TIME: 09-08-94 13:25:58
PROJECT NO., FY, & TITLE: 12172 FY 1994 CENTRAL HEATING PLANT STUDY
INSTALLATION & LOCATION: USACERL PENNSYLVANNIA
DESIGN FEATURE: ALT 4B-G/O BOIL W/WOOD & CHILL
ALT. ID. A;
NAME OF DESIGNER: SCI

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN99
ANNUAL PAYMENTS OCCUR: JUL99 THROUGH JUL23

PAY	ELECT	NAT G	M & R	R / R	OTHER
1	2306385.	951395.	754003.	343882.	0.
2	2233467.	942974.	720156.	0.	0.
3	2158096.	932622.	687828.	0.	0.
4	2090819.	928318.	656951.	27773.	0.
5	2021660.	923259.	627460.	87041.	0.
6	1950338.	912310.	599294.	0.	0.
7	1861278.	892951.	572391.	0.	0.
8	1780000.	883227.	546697.	155466.	0.
9	1715504.	880435.	522155.	0.	0.
10	1643545.	869844.	498716.	0.	0.
11	1577075.	854845.	476328.	19162.	0.
12	1509543.	832151.	454946.	0.	0.
13	1442891.	804798.	434523.	0.	0.
14	1379217.	778644.	415017.	171069.	0.
15	1318395.	753635.	396387.	0.	0.
16	1260269.	729303.	378593.	18381.	0.
17	1204580.	703374.	361598.	0.	0.
18	1151320.	677576.	345366.	0.	0.
19	1100495.	653709.	329862.	0.	0.
20	1051875.	629965.	315055.	7430.	0.
21	1005457.	607660.	300912.	0.	0.
22	961059.	585491.	287404.	0.	0.
23	918671.	564658.	274502.	0.	0.
24	878127.	543972.	262180.	6269.	0.
25	839363.	523741.	250411.	0.	0.
***	********	********	********	836474.	0.

*NET PW EQUIVALENTS ON SEP94; IN 10**0 DOLLARS; IN CONSTANT SEP94 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

Appendix C: Vendor Data

PRO•THERM
PROCESS AND THERMAL SYSTEMS

Files
12172

RECEIVED
JUL 11 1994
STANLEY CONSULTANTS

July 6, 1994

Mr. Rich Carroll
Stanley Consultants
3rd and Iowa
Muscatine, IA 52761

RE: New Boiler Project
Protherm No. 64175

Dear Mr. Carroll:

We are pleased to provide the attached quotation for your new boiler project. Our proposal includes: Two (2) new 75,000 LB/HR Nebraska D-Type Watertube Boiler with a Todd Combustion Low NOx Burner. Also included is an economizer and stack. In addition we are including budgetary pricing for one (1) 600 H.P. York-Shipley Firetube Boiler with a Low NOx Burner and Stack.

We have included equipment engineering assistance as described in our proposal to assist you with review of approval drawings and interpretation of equipment specifications for your installing contractor.

Protherm Corporation is an engineering and equipment sales firm specializing in boilers and steam systems equipment. We are experienced in providing engineering assistance as well as field startup and maintenance assistance for all of the equipment which we are proposing for you.

In conclusion, we would welcome the opportunity to work with you on this new boiler project. We are committed to providing the products and services which you need to quickly and efficiently bring this new system on line for you and we will stay with the project until you are satisfied.

If you have any questions, please call me. We look forward to serving you on this project.

Sincerely,

Ed Wiesehan

PROTHERM CORPORATION
Edward C. Wiesehan

Enclosures

b:64175L01

Reply to:
PROTHERM CORPORATION
☒ 11141 C South Towne Square • St. Louis, MO 63123-7822 • ph. (314) 894-6720 • fax (314) 892-0107
☐ P.O. Box 25426 • Shawnee Mission, KS 66225-5426 • ph. (913) 491-9856 • fax (913) 491-9857

PRO·THERM
PROCESS AND THERMAL SYSTEMS

QUOTATION

July 6, 1994

Mr. Rich Carroll
Stanley Consultants
3rd and Iowa
Muscatine, IA 52761

Reference: New Boiler Project Protherm: 64175Q01

Dear Mr. Carroll:

We are pleased to make the following budgetary quotation in accordance with your request.

QTY.	PRICE	DESCRIPTION
1 lot	$844,000/lot	Total price for two 75,000 LB/HR Water Tube Steam Generator Equipment Package including the items as described below.

1) Two Nebraska Model NS-E-65, 75,000 LB/HR Water Tube Steam Generator, 250 psig design, 150 psig operating pressures.
2) Two Todd Combustion Low NOx Burners for Natural Gas and #2 Fuel Oil with forced draft fan.
3) Two Economizers, transitions, and support structures.
4) Two stacks to extend flue gas outlet to 30 ft. above grade.
5) Start-up Service.
6) Boiler and Economizer Design Performance Data.
7) Protherm will also provide the following engineering services to Stanley Consultants with the above package:
   1. Single source engineering responsibility for all equipment in above package. Protherm will review all drawings and equipment data to coordinate work from all equipment vendors. We will also review the drawings and specifications with your engineering department to assure your satisfaction with our selections.
   2. Protherm will meet with your installing contractor(s) to discuss installation procedures, assembly details, and inter-connections.

Protherm Corporation • 11141 C South Towne Square • St. Louis, MO 63123-7822
(314) 894-6720 • FAX (314) 892-0107

PRO·THERM
PROCESS AND THERMAL SYSTEMS

QUOTATION

Mr. Rich Carroll
Stanley Consultants
Protherm No. 64175Q01
July 6, 1994
Page 2

3. Protherm will coordinate and assist with startup work of all equipment vendors to meet Stanley Consultants schedules and startup requirements.

Optional Adder

QTY.	PRICE	DESCRIPTION
1 lot	$130,000/lot	Budgetary add for Remote Control Panels including flame safeguard, combustion controller, feedwater controller, recorders and gauges not included in above package.

Firetube Boiler: 600 HP

QTY.	PRICE	DESCRIPTION
Lot	$ 97,145/lot	York-Shipley model 588 YSH 600 N/2-LN steam generator. Unit will produce 20,700 pounds/hour of 150 psig steam when fired with either Natural Gas or #2 Fuel Oil. Unit is guaranteed to fire at 80% efficiency or above when fired as serviced by York-Shipley representative. Unit will have <30 ppm NOx when fired on gas an <40 ppm NOx when fired on oil. Guaranteed turndown of greater than 14:1 when fired on gas and greater than 8:1 when fired on oil. Burner requires gas for pilot when fired on #2 oil.

Unit is complete with the following:
- IRI compliance
- YS7000 Flame controller and detector
- ASME Code stamped
- Hinged rear cover
- Full modulation
- Low fire hold switch
- 30 Ft. High carbon steel stack

Electrical Requirements:
- 440V/3ph/60 HZ 75 AMP Service

Service:
- 5 Consecutive days of factory service at $750/day
- Expenses to be billed at actual cost.

Protherm Corporation • 11141 C South Towne Square • St. Louis, MO 63123-7822
(314) 894-6720 • FAX (314) 892-0107

PRO·THERM
PROCESS AND THERMAL SYSTEMS

QUOTATION

Mr. Rich Carroll
Stanley Consultants
Protherm No. 64175Q01
July 6, 1994
Page 3

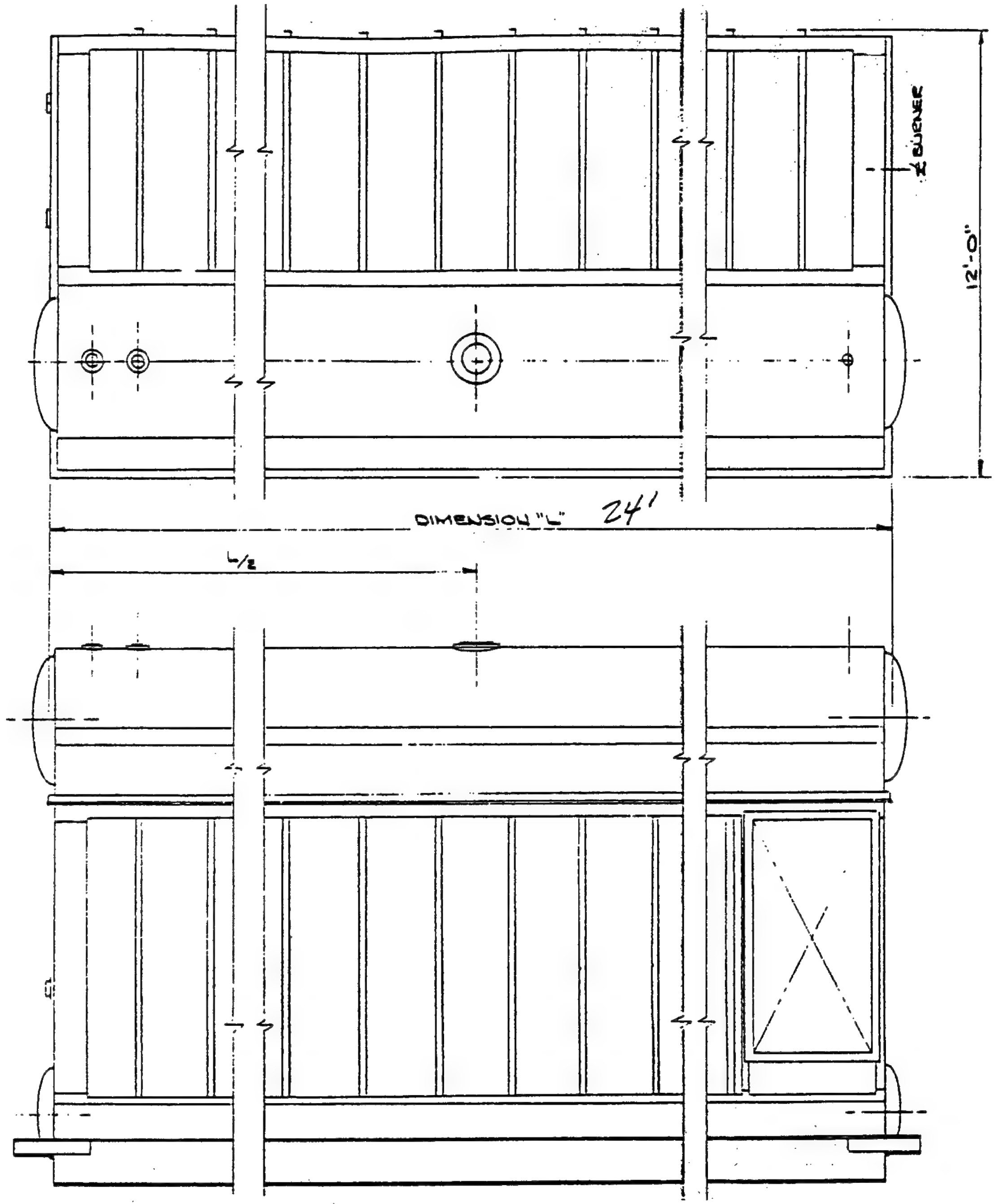
F.O.B.:	Destination. Full freight allowed in above pricing delivered at the nearest railroad siding.
DRAWINGS:	8 weeks after receipt of order.
DELIVERY:	16-18 weeks after drawing approval and release to fabricate.
PAYMENT:	25% Net 30 days after submittal of approval drawings. 75% Net 15 days after shipment of equipment or notification of ready to ship.
TAXES:	State and local taxes are not included in above pricing.

THIS PROPOSAL IS GOOD FOR THIRTY DAYS. If you have any questions or need further information to complete your evaluation, please call me. We look forward to serving you on this project.

E.C. Wiesehan

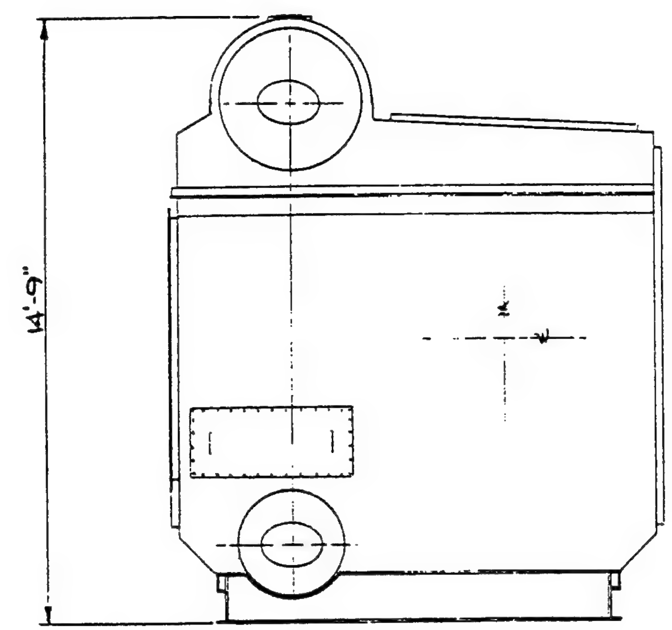
PROTHERM CORP.
Edward C. Wiesehan

Protherm Corporation • 11141 C South Towne Square • St. Louis, MO 63123-7822
(314) 894-6720 • FAX (314) 892-0107



N·B	SERIES NS·E			DRAWING NO. S-9-905b	ISSUE 0
	DRN: LRP	CKD: WH	SCALE: 1/4"	DATE: 5-31-73	JOB NO. STANDARD

NEBRASKA BOILER COMPANY INC. LINCOLN, NEBRASKA



	SERIES NS·E			DRAWING NO. S-9-905a	ISSUE 0
	DRN: ESD	CKD: WH	SCALE: ¼"	DATE: 5-31-73	JOB NO. STANDARD

NEBRASKA BOILER COMPANY INC. LINCOLN, NEBRASKA

Overall Width= 12'-0"
Overall Height= 14'-9"

NEBRASKA BOILER COMPANY
SERIES NS-E

42" I.D. Steam Drum
30" I.D. Water Drum

No. Rows	Effective Total H.S.	ASME Total H.S.	Convection H.S.	Effective Radiant H.S.	ASME Radiant H.S.	Furnace Volume	Boiler Length Dim. "L"	Boiler Weight Dry	Water Weight
45	4007	3845	3346	661	499	921	17'-4"	75,800	17,000
46	4094	3929	3419	675	510	941	17'-8"	76,600	17,350
47	4180	4011	3491	689	520	962	18'-0"	77,500	17,700
48	4266	4095	3564	702	531	982	18'-4"	78,400	18,000
49	4353	4179	3637	716	542	1003	18'-8"	79,200	18,350
50	4440	4262	3710	730	552	1023	19'-0"	80,100	18,700
51	4526	4345	3782	744	563	1044	19'-4"	80,900	19,050
52	4613	4429	3855	758	574	1065	19'-8"	81,800	19,400
53	4700	4513	3928	772	585	1085	20'-0"	82,700	19,700
54	4785	4595	4000	785	595	1106	20'-4"	83,500	20,050
55	4872	4679	4073	799	606	1126	20'-8"	84,400	20,400
56	4959	4763	4146	813	617	1147	21'-0"	85,200	20,750
57	5046	4846	4219	827	627	1167	21'-4"	86,100	21,100
58	5132	4929	4291	841	638	1188	21'-8"	87,000	21,400
59	5218	5013	4364	854	649	1209	22'-0"	87,800	21,750
60	5305	5097	4437	868	660	1229	22'-4"	88,700	22,100
61	5392	5180	4510	882	670	1250	22'-8"	89,500	22,450
62	5478	5263	4582	896	681	1270	23'-0"	90,400	22,800
63	5565	5347	4655	910	692	1291	23'-4"	91,300	23,100
64	5651	5430	4728	923	702	1312	23'-8"	92,100	23,450
65	5738	5514	4801	937	713	1332	24'-0"	93,000	23,800
66	5824	5597	4873	951	724	1353	24'-4"	93,800	24,150
67	5911	5681	4946	965	735	1373	24'-8"	94,700	24,500
68	5998	5764	5019	979	745	1394	25'-0"	95,600	24,850
69	6085	5848	5092	993	756	1414	25'-4"	96,400	25,150
70	6170	5931	5164	1006	767	1435	25'-8"	97,300	25,500
71	6257	6014	5237	1020	777	1456	26'-0"	98,100	25,850
72	6344	6098	5310	1034	788	1476	26'-4"	99,000	26,200
73	6431	6182	5383	1048	799	1497	26'-8"	99,900	26,550

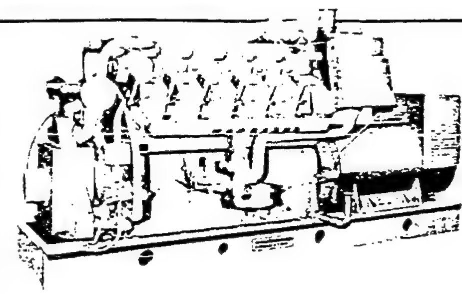
WAUKESHA

Gas Enginator® Generating System

7100GSI
765 to 1350 kW

BASIC SPECIFICATIONS

AIR CLEANERS - Dry panel type with rain shield and service indicators.
BARRING DEVICE
BEARINGS - Heavy duty, replaceable, precision type.
BREATHER - Closed system.
CONNECTING RODS - Forged steel, rifle drilled.
COOLING SYSTEM - Choice of mounted radiator with pusher fan, core guard and duct adaptor, heat exchanger with surge tank, or connection for remote radiator cooling.
CRANKCASE - Integral crankcase and cylinder frame.
CRANKSHAFT - Counterweighted, forged steel, hardened journals, dynamically balanced, with sealed viscous vibration damper.
CYLINDER HEADS - Interchangeable valve-in-head type. Two stellite faced intake and two stellite faced inconel exhaust valves per cylinder. Stellite intake and exhaust valve seat inserts.
CYLINDERS - 9.375" (238 mm) bore x 8.5" (216 mm) stroke. Removable wet cylinder liners. Number of cylinders - Twelve.
ENGINATOR® BASE - Engine, generator and radiator or heat exchanger are mounted and aligned on a welded steel, wide flange base, designed for solid mounting on an inertia block, with standard through–base holes for lifting.
ENGINE PROTECTION SHUTDOWN CONTACTS - For high water temperature, low oil pressure, high intake manifold temperature (standard engine mounted thermocouples with two thermocouple relays - shipped loose) and overspeed (electronic speed switch - shipped loose). Two engine mounted on/off pushbuttons are supplied, one on each side of the engine. Use all of the above in conjunction with a DC control panel for unit shutdown, (reference WPS Engomatic® controls).
Note: DC shutdown control panel is not supplied as standard.
EXHAUST SYSTEM - Water cooled exhaust manifold with single vertical exhaust at rear. Flexible stainless steel exhaust connection 8" (203 mm) long with 8" (203 mm) outlet flange.
FUEL SYSTEM - Dual natural gas carburetors and Fisher gas regulators, Model 99. 24 VDC gas solenoid valve (shipped loose). Gas pressure recommended 20-25 psi (1.4-1.8 kg/cm²). Single fuel connection point.
GENERATOR - Waukesha, open, dripproof, direct connected, fan cooled, 2/3 pitch, A.C. revolving field type, single bearing generator with brushless exciter and damper windings. TIF and Deviation Factor within NEMA MG-1.22. Voltage 480/277, 3 phase, 4 wire, Wye 60 Hz and 400/231, 3 phase, 4 wire, Wye 50 Hz. Other voltages are available, consult factory. Insulation material NEMA Class F. Temperature rise within NEMA (105° C) for prime power duty, within NEMA (130° C) for continuous standby duty. All generators are rated at 0.8 Power Factor, are mounted on the engine flywheel housing and have multiple steel disc flexible coupling drive. All prime power gensets have 10% overload capacity.
GOVERNOR - Woodward Model EG3P electric actuator (mounted) and magnetic pickup (mounted). Requires a separate electric governor control, Woodward Model 2301A or similar, (not included).
IGNITION - Waukesha Custom Engine Control® (CEC) Ignition Module, high energy, solid state type, with coils and harness.
INSTRUMENT CONNECTIONS - Engine mounted junction box includes ungrounded type K thermocouples for jacket water temperature, and lube oil temperature. A single header block for lube oil pressure and intake manifold pressure is engine mounted. Instruments and panel are by others. Recommend optional Model 4000 remote engine instrument panel, especially for prime power installations.



Enginator® shown with options.

Turbocharged and Intercooled
Gas Fueled Enginator®

SPECIFICATIONS

ENGINE: Waukesha L7042GSI, Four Cycle, Overhead Valve

Cylinders	V12
Piston Displacement	7040 cu. in. (115 L)
Bore and Stroke	9.375" x 8.5" (238 x 216 mm)
Compression Ratio	8:1
Jacket Water System Capacity	100 gal. (379 L)
Fuel LHV	900 Btu/ft³, (33.5 J/cm³)
Lube Oil Capacity	73 gal. (276 L)
Starting System	24V Electric

INTERCOOLER - Air to water.
JUNCTION BOXES Separate AC, DC, and instrument/thermocouple junction boxes for engine wiring and external connections.
LUBRICATION - Full pressure, positive displacement pump. Full flow oil filter (shipped loose) and flexible connections (shipped loose). 50 or 60 Hz, 230 volt AC, single phase electric motor driven prelube pump with motor starter (other voltages can be specified). ***Note:*** *External control logic required to start/stop prelube pump.*
OIL COOLER - Shell and tube type. (Mounted.)
OIL PAN - Cast alloy iron base type with removable doors.
PAINT - Oilfield Orange.
PISTONS - Heavy section contour ground, oil cooled, aluminum alloy, with ni-resist top ring groove insert and floating piston pin.
STARTING EQUIPMENT - Two 24 VDC electric starting motors, crank termination switch. (Shipped loose.)
TURBOCHARGERS - Dry type, wastegate controlled.
VOLTAGE REGULATOR - SCR static automatic type providing 1% regulation from no load to full load. Includes voltage adjustment rheostat and automatic subsynchronous speed protection. (Shipped loose.)
WATER CIRCULATING SYSTEM, AUXILIARY CIRCUIT - For oil cooler and/or intercooler. Pump is belt driven from crankshaft pulley.
WATER CIRCULATING SYSTEM, ENGINE JACKET - Belt driven water pump, 175 - 180° F (79 - 82° C) thermostatic temperature regulation full flow bypass. Water pump pulley diameter is 10" (254 mm) on units at 900 rpm or above.

PERFORMANCE DATA

HEAT EXCHANGER COOLING Intercooler Water: 85° F (29° C)	PRIME POWER*			STANDBY POWER	
	1200 rpm	900 rpm	1000 rpm	1200 rpm	1000 rpm
	60 Hz		50 Hz	60 Hz	50 Hz
kW Rating	**1100**	**825**	**920**	**1350**	**1125**
Fuel Consumption x 1000 Btu/h (kW)	12234 (3586)	8825 (2586)	9972 (2923)	14563 (4268)	11875 (3480)
Jacket Water x 1000 Btu/h (kW)	3543 (1038)	2594 (760)	2965 (866)	4125 (1203)	3434 (1006)
Intercooler x 1000 Btu/h (kW)	365 (107)	163 (48)	229 (67)	575 (169)	359 (105)
Lube Oil x 1000 Btu/h (kW)	356 (104)	291 (85)	314 (92)	389 (114)	344 (101)
Heat Radiated x 1000 Btu/h (kW)	854 (250)	742 (217)	761 (223)	813 (238)	708 (207)
Exhaust Heat** x 1000 Btu/h (kW)	3363 (986)	2220 (651)	2574 (754)	4055 (1188)	3192 (936)
Exhaust Flow lb/h (kg/h)	10467 (4748)	7550 (3425)	8537 (3872)	12607 (5719)	10286 (4666)
Exhaust Temperature °F (°C)	1161 (627)	1057 (569)	1090 (588)	1177 (636)	1121 (605)
Induction Air Flow scfm (m^3/min)	2297 (65)	1657 (47)	1874 (53)	2769 (78)	2259 (64)
WATER CONNECTION COOLING Intercooler Water: 130° F (54° C)					
kW Rating	**1050**	**785**	**875**	**1300**	**1075**
Fuel Consumption x 1000 Btu/h (kW)	11602 (3400)	8332 (2442)	9436 (2766)	13911 (4077)	11260 (3300)
Jacket Water x 1000 Btu/h (kW)	3499 (1025)	2527 (741)	2893 (848)	4117 (1207)	3382 (991)
Intercooler x 1000 Btu/h (kW)	228 (67)	89 (26)	120 (35)	401 (118)	212 (62)
Lube Oil x 1000 Btu/h (kW)	350 (103)	285 (84)	308 (90)	382 (112)	338 (99)
Heat Radiated x 1000 Btu/h (kW)	447 (131)	708 (207)	766 (224)	878 (257)	781 (229)
Exhaust Heat** x 1000 Btu/h (kW)	3495 (1024)	2045 (599)	2364 (693)	3697 (1084)	2879 (844)
Exhaust Flow lb/h (kg/h)	9927 (4503)	7129 (3234)	8078 (3664)	12044 (5463)	9750 (4423)
Exhaust Temperature °F (°C)	1125 (607)	1031 (555)	1058 (570)	1145 (618)	1096 (591)
Induction Air Flow scfm (m^3/min)	2179 (52)	1565 (44)	1773 (50)	2645 (75)	2141 (61)
RADIATOR COOLING - MOUNTED Intercooler Water: 130° F (54° C)					
kW Rating	**1000**	**765**	**840**	**1260**	**1050**
Fuel Consumption x 1000 Btu/h (kW)	11395 (3340)	8307 (2435)	9315 (2730)	13868 (4064)	11201 (3283)
Jacket Water x 1000 Btu/h (kW)	3444 (1009)	2520 (739)	2861 (839)	4106 (1203)	3366 (987)
Intercooler x 1000 Btu/h (kW)	215 (63)	88 (26)	115 (34)	397 (116)	209 (61)
Lube Oil x 1000 Btu/h (kW)	347 (102)	285 (84)	306 (90)	381 (112)	337 (99)
Heat Radiated x 1000 Btu/h (kW)	835 (245)	702 (206)	760 (223)	872 (255)	791 (229)
Exhaust Heat** x 1000 Btu/h (kW)	3040 (891)	2038 (597)	2331 (683)	3686 (1080)	2862 (839)
Exhaust Flow lb/h (kg/h)	9740 (4418)	7106 (3223)	7968 (3614)	12004 (5445)	9696 (4398)
Exhaust Temperature °F (°C)	1123 (606)	1030 (554)	1055 (568)	1145 (618)	1095 (591)
Induction Air Flow scfm (m^3/min)	2138 (61)	1560 (44)	1749 (50)	2637 (75)	2130 (60)
Radiator Air Flow scfm (m^3/min)	112000 (3172)	80000 (2266)	92000 (2605)	122000 (3455)	97000 (2747)

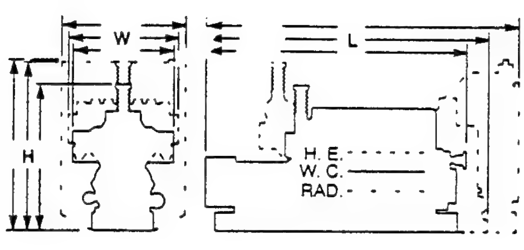
Typical heat balance data is shown. Consult factory for guaranteed data.

*** Prime Power Rating:** The highest load and speed which can be applied–24 hours a day, seven days a week–except for normal maintenance. The rating can include operation of the engine at up to 10% overload for two hours in each 24 hour period.

Standby Service Rating: In a system used as a backup or secondary source of electrical power, this rating is the output the system will produce continuously–24 hours a day–for the duration of the prime power source outage.

** Heat rejection based on cooling exhaust gas to 85° F (29° C)

Cooling Equipment	L in. (mm)	W in. (mm)	H in. (mm)	Avg. Wt. lb (Kg)
H. E.	218 (5540)	80 (2030)	108 (2740)	36,000 (16,330)
W. C.	201 (5110)	80 (2030)	108 (2740)	34,000 (15,425)
RAD.	238 (6050)	114 (2900)	138 (3500)	39,750 (18,030)



WAUKESHA SALES OFFICES WORLDWIDE

Brussels	Calgary	Denver	Houston	Miami	San Francisco	Singapore	Waukesha Plant
(32)(2) 354-6705	(403) 266-8666	(303) 779-5675	(713) 893-4170	(305) 370-5035	(916) 784-1992	(65) 737-7955	(414) 547-3311

Consult your local Waukesha Distributor for system application assistance. The manufacturer reserves the right to change or modify without notice, the design or equipment specifications as herein set forth without incurring any obligation either with respect to equipment previously sold or in the process of construction except where otherwise specifically guaranteed by the manufacturer.

WAUKESHA POWER SYSTEMS DRESSER

WAUKESHA ENGINE DIVISION
DRESSER INDUSTRIES, INC.
WAUKESHA, WISCONSIN 53188-4999

Bulletin 8010 1/93

Printed on Recycled Paper

'94 09:22 FROM SOLAR TURBINES INC TO 13192646658 PAGE.003

...BINES INCORPORATED DATE RUN: 5-JUL-94
... PERFORMANCE CODE REV. 2.63 RUN BY: Chicago Sales Office
...MER: Stanley Consultants
JO :

NEW EQUIPMENT PREDICTED EMISSION PERFORMANCE
DATA FOR POINT NUMBER 3

Fuel: SD NATURAL GAS Customer: Stanley Consultants
Water Injection: NO Inquiry Number:
Number of Engines Tested: 4
Model: SATURN 20-T1501 GSC STANDARD GAS
NEW STANDARD (LOW CO) COMBUSTOR
Emissions Data: REV. 0.1

CRITICAL WARNINGS IN USE OF DATA FOR PERMITTING

1. Short term permitting values such as PPMV or lbs/hr should be based on worst case actual operating conditions specific to the application and the site. Worst case for one pollutant is not necessarily the same for another. The values on this form are only predicted emissions at one specific operating condition; not necessarily the worst case.

2. Long term reference emission units (e.g. tons/yr) should reference the average conditions at the site (e.g. ISO). That number should not be derived from the worst case value referenced above, or conversely this average must not be used to calculate worst case.

3. Nominal values are based on actual test results, or predicted in the case of no actual engine tests. Expected maximum values should be referenced for permitting.

4. If a SoLoNOx model is planned to be installed in the future, use no less than 50 PPMv CO.

The following predicted emissions performance is based on the following specific single point: (see attached)

kW= 1036, %Full Load= 100.0, Elev= 350 ft, %RH= 60.0, Temperature= 60.0 F

NOX		CO		UHC		
NOM	MAX	NOM	MAX	NOM	MAX	
86.59	101.00	26.85	50.00	13.090	25.000	PPMvd at 15% O2
23.51	27.43	4.44	8.27	1.239	2.367	ton/yr
0.345	0.402	0.065	0.121	0.0182	0.0347	lbm/MMBtu (Fuel LHV)

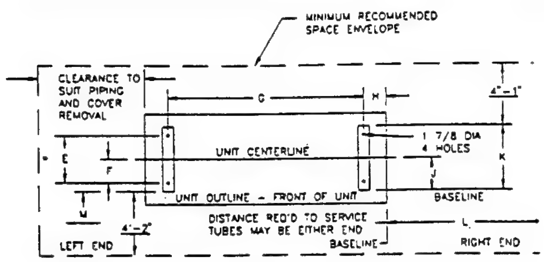
OTHER IMPORTANT NOTES

1. Solar does not provide maximum values for water-to-fuel ratio, SOx, particulates, or conditions outside those above without separate written approval.
2. Solar can optionally provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
3. Fuel must meet Solar standard fuel specification ES 9-98. Predicted emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If the above information is being used regarding existing equipment, it should be verified by actual site testing.

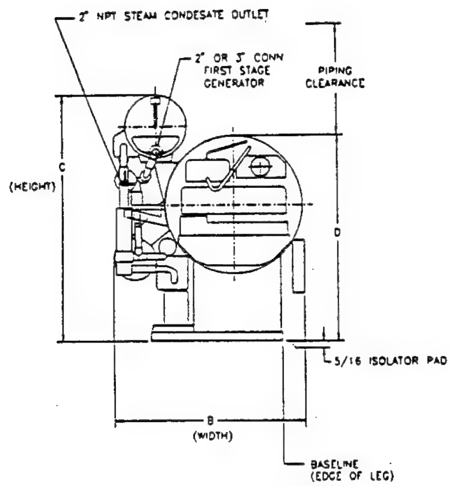
** TOTAL PAGE.003 **

TRANE™

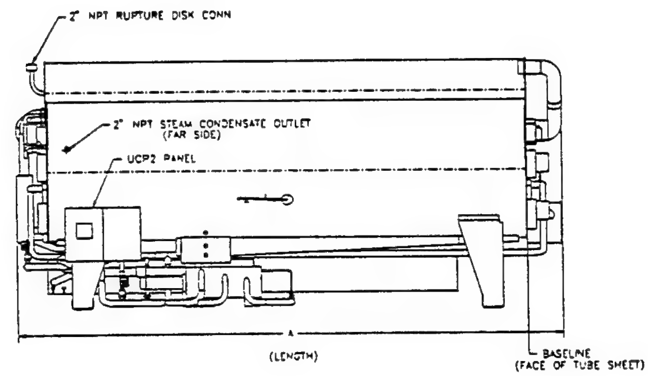
Dimensional Data



PLAN VIEW



LEFT END ELEVATION



MODEL ABTE	A	B	C	D	E	F
385	18'2" (5537)	9'4" (2845)	11'8" (3556)	9'5" (2870)	6'0" (1829)	1'6.5" (470)
465	21'1" (6426)	9'4" (2845)	11'8" (3556)	9'5" (2870)	6'0" (1829)	1'6.5" (470)
527	23'3" (7087)	9'4" (2845)	11'8" (3556)	9'5" (2870)	6'0" (1829)	1'6.5" (470)
590	20'9" (6325)	9'8" (2946)	12'8" (3861)	10'5" (3175)	5'4" (1626)	1'8" (508)
656	22'11" (6985)	9'8" (2946)	12'8" (3861)	10'5" (3175)	5'4" (1626)	1'8" (508)
750	25'5" (7747)	9'8" (2946)	12'8" (3861)	10'5" (3175)	5'4" (1626)	1'8" (508)
852	23'1" (7036)	10'5" (3175)	13'5" (4089)	11'3" (3429)	6'5" (1956)	2'1" (635)
935	25'7" (7798)	10'5" (3175)	13'5" (4089)	11'3" (3429)	6'5" (1956)	2'1" (635)
1060	29'5" (8966)	10'5" (3175)	13'5" (4089)	11'3" (3429)	6'5" (1956)	2'1" (635)

MODEL ABTE	G	H	J	K	L	M
385	11'5" (3480)	1'6" (457)	2'2.5" (673)	7'4" (2235)	15'5" (4700)	8" (203)
465	14'4" (4369)	1'6" (457)	2'2.5" (673)	7'4" (2235)	18'4" (5588)	8" (203)
527	16'6.5" (5042)	1'6" (457)	2'2.5" (673)	7'4" (2235)	20'7" (6274)	8" (203)
590	13'10.5" (4229)	1'9" (533)	2'4" (711)	7'8" (2337)	18'5" (5613)	8" (203)
656	16'1" (4902)	1'9" (533)	2'4" (711)	7'8" (2337)	20'7" (6274)	8" (203)
750	18'6.5" (5652)	1'9" (533)	2'4" (711)	7'8" (2337)	23'1" (7036)	8" (203)
852	15'10" (4826)	1'10" (559)	2'4" (711)	8'7" (2616)	20'7" (6274)	6.5"(165)
935	18'3.5" (5575)	1'10" (559)	2'4" (711)	8'7" (2616)	23'1" (7036)	6.5"(165)
1060	22'1.5" (6744)	1'10" (559)	2'4" (711)	8'7" (2616)	26'11" (8204)	6.5"(165)

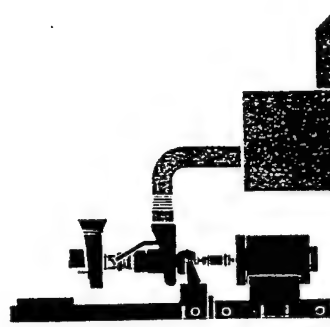
( ) = mm

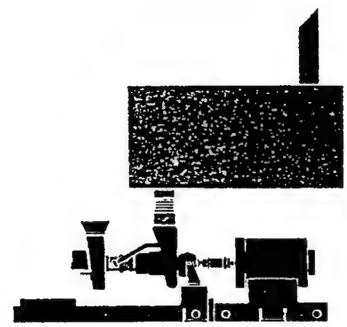
All dimensions approximate. Refer to submittals for exact dimensions and further information.

Solar Turbines
A Caterpillar Company
Solar Turbines Incorporated
P.O. Box 85376
San Diego, CA 92186-5376

HEAT RECOVERY
Performance

Site Examples





Steam Producing*

	Saturn 20 Turbine	Centaur 40 Turbine	Centaur 50 Turbine	Centaur 60 Turbine	Mars 90 Turbine	Mars 100 Turbine
Stack Temp °F	310	322	367	311	316	370
Steam Output lb/hr	7435	13 413	20,790	24,097	40,450	42,125
Exhaust Temp °F	915	844	956	905	878	937
Fuel Input million Btu/hr	15 8	42 2	48 8	54.3	95.9	106.1
Electrical Output kW	1097	3312	3914	4727	8562	9739
Air Mass Flow thousand lb/hr	50 8	146	145	168	298	305.3
Net System Efficiency %	70.2	70 4	70 0	74.1	72.6	71.0

Turbine exhaust producing 150 psig steam.

Supplemental Firing*

	Saturn 20 Turbine	Centaur 40 Turbine	Centaur 50 Turbine	Centaur 60 Turbine	Mars 90 Turbine	Mars 100 Turbine
Stack Temp °F	275	275	275	275	275	275
Steam Output lb/hr	16,592	53 664	53 060	61 529	109 232	111,784
Additional Fuel to Burner million Btu/hr	11.2	35 0	30 3	37 4	68 5	65 3
Exhaust Temp °F	915	844	956	905	878	937
Turbine Fuel Input million Btu/hr	15 8	42 2	48 8	54 3	95 9	106.1
Electrical Output kW	1097	3312	3914	4727	8562	9739
Air Mass Flow thousand lb/hr	50.8	146	145	168	298	305.3
Net System Efficiency %	82.7	84.2	84 0	84.7	84 2	84.6

This example assumes exhaust with supplemental firing to 1700°F in 150 psig boiler

Hot Air Source*

	Saturn 20 Turbine	Centaur 40 Turbine	Centaur 50 Turbine	Centaur 60 Turbine	Mars 90 Turbine	Mars 100 Turbine
Heat Credit million Btu/hr	11 2	29 4	33 6	36 6	62 7	69 3
Exhaust Temp °F	915	844	956	905	878	937
Fuel Input million Btu/hr	15 8	42 2	48 8	54 3	95 9	106 1
Electrical Output kW	1097	3312	3914	4727	8562	9740
Air Mass Flow thousand lb/hr	50 8	146	145	168	298	305.3
Net System Efficiency %	94 6	96 4	96 2	97 1	95 8	96.6

Cogeneration system with turbine exhaust used directly as hot air source.

708 ... 1998
JUN 20 '94 09:57 FROM SOLAR TURBINES INC TO 13192646658 PAGE.001

CATERPILLAR®

Solar Turbines Incorporated

One Energy Center
40 Shuman, Suite 350
Naperville, IL 60563
Sales: Tel: (708) 527-1700
Fax: (708) 527-1998
Customer Service:
Tel: (708) 527-1466
Fax: (708) 527-1997

June 20, 1994

Mr. Rich Carroll
Stanley Consultants
Fax: 319-264-6658

Dear Mr. Carroll,

Thank you for your interest in Solar Turbines, Inc. Attached please find a budgetary quote and scope of supply for the Saturn 20 (1500).

If I can be of any further assistance please do not hesitate to call.

Sincerely,

Judy A. Wilhelm

Judy A. Wilhelm
Sales Coordinator
Industrial Power Generation

Solar Turbines

94 09:57 FROM SOLAR TURBINES INC TO 13192646658 PAGE.002

Budget Quotation
Stanley Consultants
Inquiry No. CH4-419
June 20, 1994

Saturn T-1500 Power Pak (includes) . . . .$ 550,000

Continuous Duty Rating
Natural Gas Fuel
Epicyclic Reduction Gear
480v Generator
Electric Hydraulic Start
Dual Oil Filter System
Pre/post Lube 460v 60 hz
Lube Oil Cooler 460v 60 hz
Lube Oil Vent Separator
Turbine Microprocessor Controls
Turbine Compressor Cleaning
Turbine Vibration monitor
Generator Controls
- Synchroscope
- kW Controller
- KVAR/PF Control

Temperature Monitoring
Battery System - Ni-Cad

Air Induction System (includes)

Air Inlet Silencer
Self Cleaning Barrier Filter

Gen Set Enclosure (includes)

Vent Silencers
230/460v Vent Fan
110 vac Lighting
CO_2 Fire Protection
Combustible Gas Monitor
High Temperature Alarm

(Continued)

HEAT RECOVERY

Performance

ISO Performance

The ability to use gas turbine exhaust for heat recovery, supplemental firing, and in a wide range of high heat-to-electrical power ratio applications makes the gas turbine the leading prime mover for cogeneration systems. Available exhaust heat energy and net electrical output of Solar gas turbine generator sets at ISO conditions are given below.

	Saturn 20 Turbine	Centaur 40 Turbine	Centaur 50 Turbine	Centaur 60 Turbine	Mars 90 Turbine	Mars 100 Turbine
Exhaust Temp °F	911	841	952	901	874	933
Fuel Input million Btu/hr	16.01	42.69	49.30	54.85	96.96	107.20
Electrical Output kW	1138	3427	4040	4875	8821	10,000
Exhaust Flow thousand lb/hr	51.2	147.7	146.3	169.6	301.1	308.2

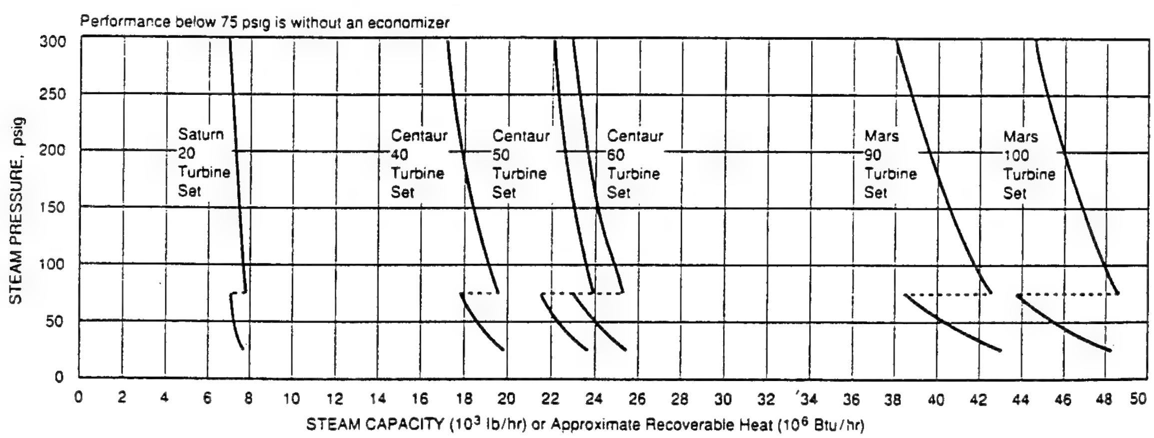
Specific Site Examples

The values shown in the examples on the back of this page are based on the following tables:

ASSUMPTIONS:	
Ambient conditions	Sea level and 60°F
Fuel	Gas
Load	100%
Inlet pressure loss	3 inches water
Exhaust pressure loss	7 inches water

STEAM DATA:	
Condensate return	200°F
Steam conditions	Dry and saturated
Pinch temperature	30°F
Alternate boiler efficiency	80%

Steam Produced from Solar Gas Turbines



Solar Turbines
A Caterpillar Company

MARLEY

The Marley Cooling Tower Company

Represented by R.S STOVER COMPANY PHONE (515) 753-5557
3809 SOUTH CENTER — P O BOX 398 — MARSHALLTOWN, IOWA 50158 — FAX (515) 752-1650

Date: June 14, 1994

To: Stanley Consultants
225 Iowa Street
Muscatine, IA 52761

Project: New Cumberland, PA

Proposal #0532-94-GM-124

RECEIVED
JUN 16 1994
STANLEY CONSULTANTS

Attention: Rich Carol

We propose to furnish the following Marley cooling tower:

Model: NC8021 Number of cells: 1
Design: 2500 GPM 95 °F Hot Water 85 °F Cold Water 75 °F Wet Bulb
Dimensions Per Cell:
Length 11'0" Width 22'0" Height 20'0"
Weight (Pounds):
Shipping Weight 15,295 per cell 15,295 total Wet Operating Weight 31,500
Motor(s): Quantity 1 Enclosure TEFC
Phase 3 Hertz 60 Voltage 460 Speeds 1 Winding 1 HP ~~40~~ RPM 1800

INCLUDES: Flow Control Valves
Vibration Safety switch
motor outside airsteam
handrail & ladder

Net Price, F.O.B. Shipping Point $ 43,000.00
Freight to New Cumberland, PA $ INCLUDED
Total (plus tax, not included) $ 43,000.00 Budget Price

Shipment: 4 to 6 weeks after drawing approval and your release

We thank you for the opportunity to provide this quotation. Our deliveries are based upon receipt of an enterable order without any holds and shipment when ready. Any resulting purchase order should be made out to:

R. S. Stover Company
P.O. Box 398
Marshalltown, IA 50158

Terms:
Materials – Net 30 days from date of shipment
F. O. B. Marley Plants

Notes:
1. This proposal and the above prices will be firm if Purchaser's order is accepted by the Company within 30 days from proposal date and if shipment is to be made within 8 months from order date. Otherwise, price at time of shipment will prevail.
2. All sales, use or excise taxes payable by the Company, or to be collected by the Company from Purchaser, in connection with the sale, installation, or use of the proposed equipment shall be added to the prices quoted above at time of shipment.
3. Unless stated above, these prices do not include vibration isolation, sprinkler systems, distribution piping, valves, pumps, wiring, starters, controls, tower supports or water treating equipment.
4. Marley's responsibility for delivery is limited to date of shipment. Carrier can be requested to give a maximum of 24 hours notice of delivery.
5. Shipments involving more than one truck may arrive at the job site at different times.
6. Purchaser to receive, unload, haul, hoist and set tower(s) in place.
7. Top fan cylinder rings and guards ship unattached and must be installed by Purchaser.

Enclosures:
CC: Machael

The Marley Cooling Tower Company
R. S. STOVER COMPANY, Representative

Wesley G. Booth, Sales ext. 274

MSP 71 This proposal is subject to all provisions on reverse side of this sheet and all listed enclosures

708 527 1998
JUL 5 '94 09:21 FROM SOLAR TURBINES INC TO 13192646658 PAGE.001

CATERPILLAR®

Solar Turbines Incorporated

One Energy Center
40 Shuman, Suite 350
Naperville, IL 60563
Sales: Tel: (708) 527-1700
Fax: (708) 527-1998
Customer Service:
Tel: (708) 527-1466
Fax: (708) 527-1997

July 5, 1994

Mr. Rich Carroll
Stanley Consultants
FAX: 319-264-6658

Dear Mr. Carroll,

Thank you for your interest in Solar Turbines, Inc. Attached please find minimum performance and emissions data on the Saturn 20.

If I can be of any further assistance please do not hesitate to call.

Sincerely,

Judy A. Wilhelm

Judy A. Wilhelm
Sales Coordinator
Industrial Power Generation

Attachment

Solar® Turbines

...BINES INCORPORATED
...E PERFORMANCE CODE REV. 2.63
...ER: Stanley Consultants
JCL

DATE RUN: 5-JUL-94
RUN BY: Chicago Sales Office

SATURN 20-T1501
GSC
STANDARD
GAS
TSG-1 REV. 2.1

DATA FOR MINIMUM PERFORMANCE

Fuel Type		SD NATURAL GAS				
Elevation	Feet	350				
Inlet Loss	in. H20	4.0				
Exhaust Loss	in. H20	10.0				
Ambient Temperature	Deg. F	20.0	40.0	60.0	80.0	100.0
Relative Humidity	%	60.0	60.0	60.0	60.0	60.0
Elevation Loss	kW	18	16	15	14	12
Inlet Loss	kW	26	24	23	22	20
Exhaust Loss	kW	30	30	29	28	27
Specified Load	kW	FULL	FULL	FULL	FULL	FULL
Net Output Power	kW	1204	1126	1036	942	846
Fuel Flow	MMBtu/hr	17.17	16.45	15.58	14.72	13.84
Rate	Btu/kW-hr	14264	14601	15036	15618	16355
Inlet Air Flow	lbm/hr	52762	51093	49362	47324	44924
Engine Exhaust Flow	lbm/hr	53458	51758	49990	47915	45479
PCD	psi(g)	85.3	82.4	79.2	75.5	71.2
PT Inlet Temperature	Deg. F	1237	1246	1246	1246	1246
Compensated PTIT	Deg. F	1236	1245	1245	1245	1245
Exhaust Temperature	Deg. F	895	910	918	930	945

NOTES

This is being run for Rich Carroll, 319-264-6618, FAX: 319-264-6658.

ENERGY RECOVERY INTERNATIONAL

ERI

P.O. Box 80404
Lincoln, Nebraska 68501-0404
Telephone (402) 434-2006
Telefax (402) 434-2066

RECEIVED
JUL 8 1994
STANLEY CONSULTANTS

July 5, 1994

Stanley Consultants
Stanley Building
225 Iowa Avenue
Muscatine, IA 52761-3784

Attention: Mr. Rich Carrol

RE: Heat Recovery Steam Generator System
ERI Proposal No. P-3826-S-0

Gentlemen:

With reference to the above subject project, Energy Recovery International is pleased to offer the following budget quotation:

One (1) Energy Recovery International Model S1-0916 shop assembled heat recovery steam generator system, 200 psig design pressure, having a capacity of 7,900 lbs/hr of dry and saturated steam at an operating pressure of 120 psig when supplied with feedwater at 220°F and 51,360 lbs/hr of turbine exhaust gas at 904°F. The final stack gas exit temperature will be 307°F. The system will be complete as described in the Scope of Supply listed below.

TOTAL BUDGET PRICE........................$ 229,000.00

Stanley Consultants
Muscatine, IA

July 5, 1994
Page 2

Scope of Supply

1) Boiler Model S1-0916
2) Vertical economizer
3) Microprocessor controllers for 2-element feedwater and steam pressure control
4) Insulated transition ducts-
   a) Turbine to diverter inlet
   b) Diverter to boiler inlet
      NOTE: Expansion joint at turbine discharge to be furnished by others
5) 30" flap type diverter with insulation and pneumatic actuator
6) Bypass silencer
7) 30" bypass stack to a total elevation of 30'
8) Bypass support assembly
9) 30" main stack to a total elevation of 30' with transition to economizer outlet
10) Standard steam and feedwater trim
11) Fabric type expansion joint at diverter bypass
12) Platform / Ladder
13) ERI standard surface preparation and primer

The above price is F.O.B. factory, Lincoln, Nebraska. All shipments are subject to clearance availability.

Shipment of equipment as offered shall be made 180 days after receipt of formal order and approval of submitted drawings. Drawings shall be submitted for approval approximately 6-8 weeks after receipt of formal Purchase Order.

Terms of Sale, subject to credit approval, are 10% with order, 25% net 30 days from date of drawing submittal and 65% net 15 days from date of shipment.

Equipment warranty and other conditions of sale shall be as per our standard Terms and Conditions, a copy of which is enclosed.

The price quoted does not include any use, excise, sales, fees or other like taxes which may be applicable. Energy Recovery International may not be licensed to collect applicable taxes. Any Purchase Order issued must include a tax exemption certificate, or a direct pay permit.

We trust that the above meets with your favorable consideration and ask that you do not hesitate to contact our local representative or this office if you have any questions.

,canley Consultants
Muscatine, IA

July 5, 1994
Page 3

Assuring you of our desire to be of service, we are

Very truly yours,

ENERGY RECOVERY INTERNATIONAL

Kevin Slepicka

Kevin C. Slepicka
Application Sales Engineer

KCS:jh

enclosures

c: Walling Company
Attn: Mr. Marty Hoyt
P.O. Box 2036
Davenport, IA 52809
(319) 386-4064

BASIC® ENVIROTECH INC.
21W181 Hill Ave. Glen Ellyn, Illinois 60137 USA
Telephone 708-790-9404 Telefax 708-790-9453

August 23, 1994

Mr. Richard Carroll
Stanley Consultants
225 Iowa Avenue
Muscatine, IA 52761

RE: Budget Quote #B1129 (Harrisburg Project)
- Model 1500 BASIC Solid Waste Boiler
With Baghouse Filter

Dear Mr. Carroll:

BASIC is pleased to provide a budget quotation for its Model 1500 BASIC Solid Waste Boiler (BSWB) for a system to burn 1600 pounds per hour of wood pallet waste 24 hours per day, 7 days per week. The BASIC Model 1500 boiler has an input capacity of 12,000,000 Btu/h. The Model 1500 recovers energy in the form of steam at a production rate of approximately 14,000 pounds per hour @ 120 PSIG saturated. We have assumed the wood pallet waste material has a heating value of approximately 8,000 Btu/pound. This system can meet the current 0.10 grains/DSCF emission requirement without a Baghouse Filter, the filter adds capability to meet 0.03 grains/DSCF.

The Model 1500 Solid Waste Boiler would include as standard equipment:

1. Electro-mechanical bulk feed Loader (48" wide, 36" high, 60" long)
2. Unitized Base with BASIC Pulse Hearth® stoker system.
3. BASIC "back hoe" type automatic wet Ash Remover.
4. Water-walled primary combustion chamber (Stage 1), with #2 oil fired ignition/auxiliary fuel burners with BASIC Dryer Hearth®.
5. Two independent combustion zones of Reburn Tunnels (Stages 2 and 3). The system is designed to provide 1 full seconds of residence time at 1,700°F. #2 oil fired auxiliary fuel burner.
6. Refractory lined hot gas stack, to 40 feet above grade.
7. Main Control panel with Color Graphic operator interface and Power panel for motor control.
8. Refractory lined Safety Relief Damper with actuator on the hot gas stack.
9. Patented Stage 4™ recirculation system before boiler inlet.
10. 3-pass firetube convection boiler with sootblower.
11. Feed water Economizer with sootblower.

12. Baghouse equipped with fabric bags suitable for operation up to 450°F. Single compartment, reverse pulse jet cleaning mechanism, lift off cover clean side plenum.
13. Ductwork, dampers, ID fan and carbon steel stack to 40 ft. elevation.
14. On-site refractory work is performed by BASIC personnel.

Pricing:

Budget price for supply of Model 1500 BSWB with Baghouse Filter	1,300,000 $US
Budget price for Freight and Installation of System	994,800 $US

Prices include: the design and supply of equipment; freight to Harrisburg PA; installation on customer prepared foundation; start-up assistance; initial bake-out of refractory lining (except for fuel cost); and operator training. Scope of equipment supply is from solid waste feeder to ash remover, feed water control valve to main steam stop and check valve.

To this budget quote, one has to add foundations, building, utilities and local architect or engineer's time. Basic Envirotech Inc. is willing to assist in providing data for permit applications but costs for permitting, which might include personal visits to site, hearings, stack testing, etc., is not included and would be billed separately on a time and material basis.

Lead Time: The equipment could be shipped within approximately six (6) months after approved Purchase Order. Site construction and mechanical installation will require and additional four (4) months. Approximately six (6) weeks is required for shake-down, refractory bake-out, start-up and training efforts after completion of installation.

Terms: Progressive payments.

Very Truly Yours,
Basic Envirotech Inc.

John Basic, Jr.
President

BASIC® ENVIROTECH INC.
21W 181 Hill Ave. Glen Ellyn, Illinois 60137 USA
Telephone 708-790-9404 Telefax 708-790-9453

RECEIVED
AUG 26 1994
STANLEY CONSULTANTS

August 23, 1994

Mr. Richard Carroll
Stanley Consultants
225 Iowa Avenue
Muscatine, IA 52761

RE: Budget Quote #B1129 (Harrisburg Project)
Background Data

Dear Mr. Carroll:

To supplement our Budget Quote #B1129, we are sending several drawings and other documents for your review.

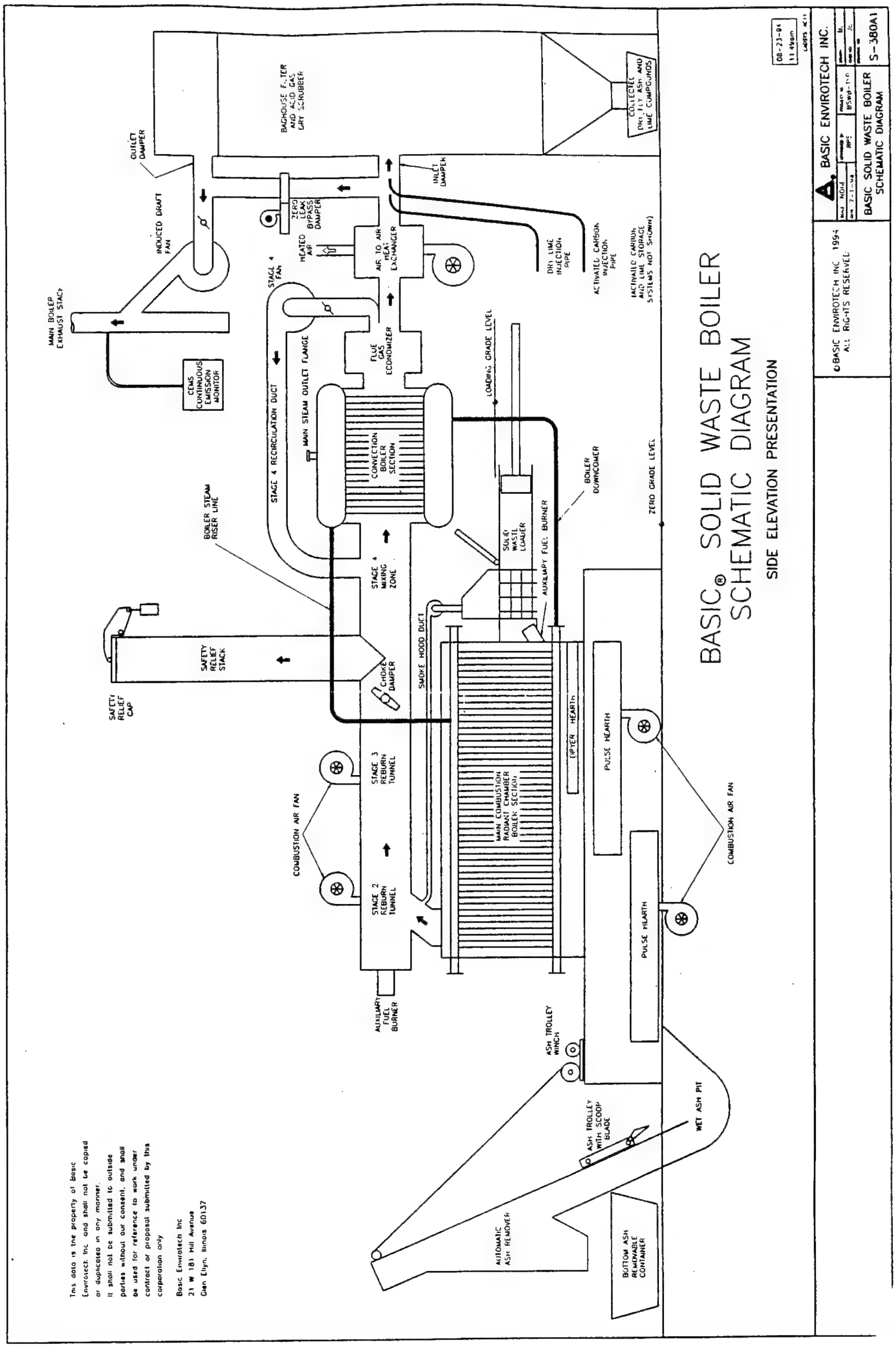
We recently shipped a Model 1500 BASIC Solid Waste Boiler to a small town in Canada for the combustion of municipal solid waste and the production of steam for a nearby food processing company. As this model is the same as we recommend for your application, I have made copies of the general arrangement drawings from that job. Please note that this layout would work better if an additional 5' of width were available in the room.

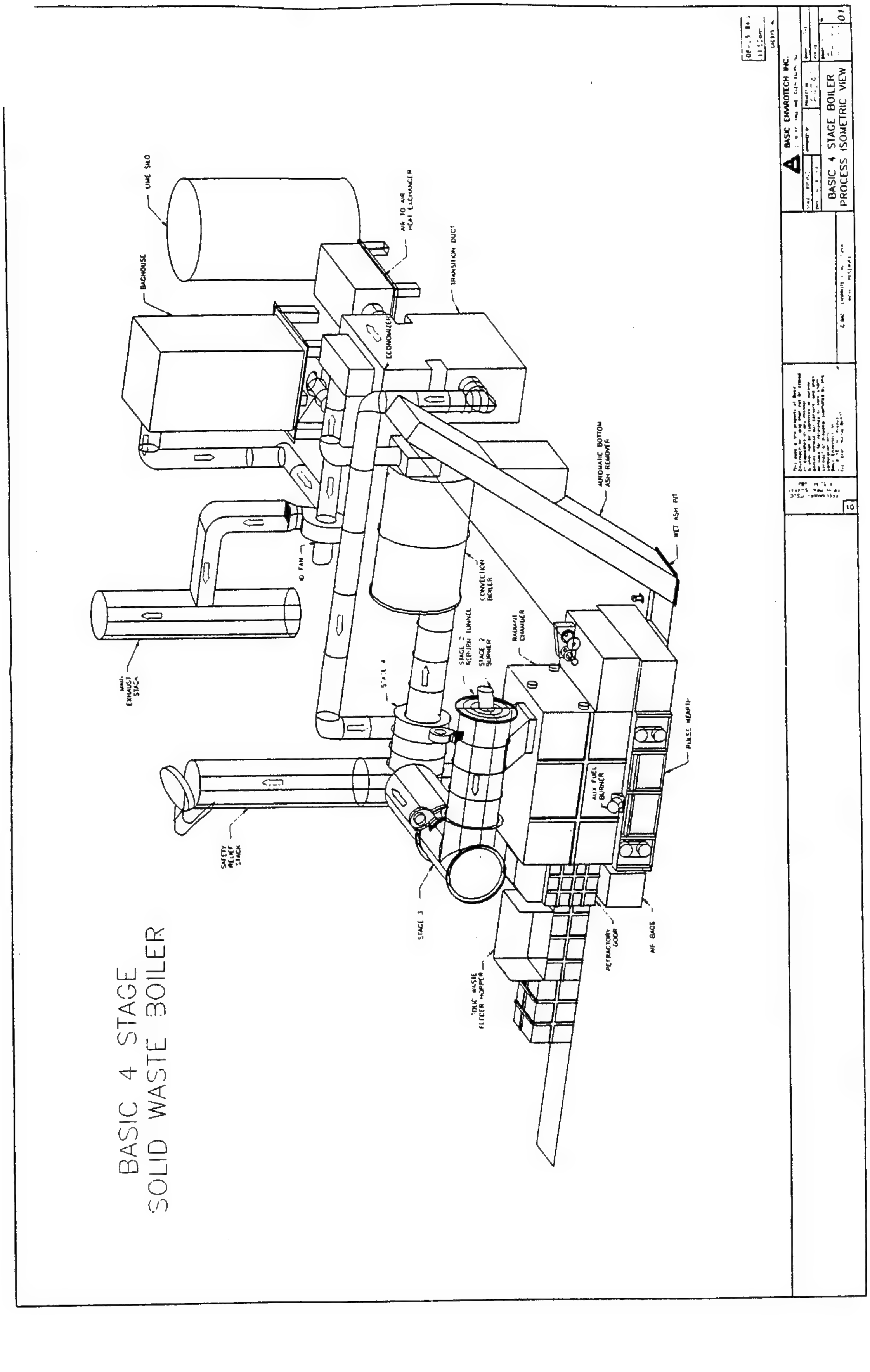
An isometric of a similar system and a schematic representation of the process are included to help you better visualize our system. I have also provided a document titled "Major Design Features of the BASIC® Solid Waste Boiler" which includes a technical appendix that describes the various components of our system.

The BASIC® system provides many advantages that are not available with lower cost 2-chamber designs. After you have had a chance to review this information, please do not hesitate to call with any questions or comments.

With Best Regards,
Basic Envirotech Inc.

John Basic, Jr.
President


BASIC® SOLID WASTE BOILER SCHEMATIC DIAGRAM
SIDE ELEVATION PRESENTATION
BAGHOUSE FILTER AND ACID GAS DRY SCRUBBER
COLLECTED DRY FLY ASH AND LIME COMPOUNDS
OUTLET DAMPER
INLET DAMPER
INDUCED DRAFT FAN
ZERO LEAK BYPASS DAMPER
HEATED AIR
AIR TO AIR HEAT EXCHANGER
DRY LIME INJECTION PIPE
ACTIVATED CARBON INJECTION PIPE
ACTIVATED CARBON AND LIME STORAGE SYSTEMS NOT SHOWN
MAIN BOILER EXHAUST STACK
STAGE 4 FAN
CEMS CONTINUOUS EMISSION MONITOR
FLUE GAS ECONOMIZER
LOADING GRADE LEVEL
MAIN STEAM OUTLET FLANGE
STAGE 4 RECIRCULATION DUCT
CONVECTION BOILER SECTION
BOILER DOWNCOMER
ZERO GRADE LEVEL
BOILER STEAM RISER LINE
SOLID WASTE LOADER
AUXILIARY FUEL BURNER
STAGE 4 MIXING ZONE
SAFETY RELIEF CAP
SAFETY RELIEF STACK
CHOKE DAMPER
SMOKE HOOD DUCT
DIPPER HEARTH
PULSE HEARTH
STAGE 3 REBURN TUNNEL
MAIN COMBUSTION RADIANT CHAMBER BOILER SECTION
COMBUSTION AIR FAN
STAGE 2 REBURN TUNNEL
AUXILIARY FUEL BURNER
PULSE HEARTH
ASH TROLLEY WINCH
ASH TROLLEY WITH SCOOP BLADE
WET ASH PIT
AUTOMATIC ASH REMOVER
BOTTOM ASH REMOVABLE CONTAINER
This data is the property of Basic Envirotech Inc. and shall not be copied or duplicated in any manner. It shall not be submitted to outside parties without our consent, and shall be used for reference to work under contract or proposal submitted by this corporation only.
Basic Envirotech Inc
21 W 181 Hill Avenue
Glen Ellyn, Illinois 60137
©BASIC ENVIROTECH INC 1994 ALL RIGHTS RESERVED
BASIC ENVIROTECH INC.
BASIC SOLID WASTE BOILER SCHEMATIC DIAGRAM
S-380A1
08-23-94


BASIC 4 STAGE
SOLID WASTE BOILER
LIME SILO
BAGHOUSE
AIR TO AIR HEAT EXCHANGER
TRANSITION DUCT
ECONOMIZER
AUTOMATIC BOTTOM ASH REMOVER
WET ASH PIT
ID FAN
CONVECTION BOILER
STAGE 2 BURNER
RADIANT CHAMBER
STAGE 4
MAIN EXHAUST STACK
SAFETY RELIEF STACK
STAGE 3
PULSE HEARTH
AUX FUEL BURNER
REFRACTORY DOOR
AIR BAGS
SOLID WASTE FEEDER HOPPER
BASIC ENVIROTECH INC.
BASIC 4 STAGE BOILER
PROCESS ISOMETRIC VIEW

TELEPHONE CALL REPORT

Date: August 10, 1994 Time 11:00 AM Job No. 12172

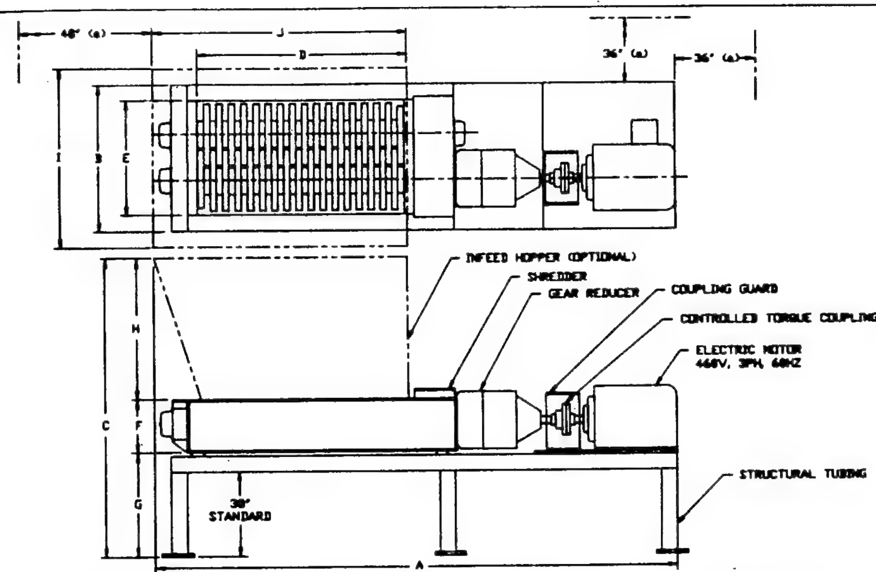
To: Dave Wilson - Shredding Systems Inc. At: Wilsonville, Oregon

From: Rich Carroll - SCI At: Muscatine, IA

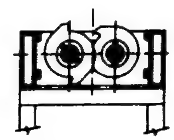
Subject: CERL DDRE
Central Heating Plant Modernization Study
Pallet Shredder

Dave stated that the price for a shredder to process 10,000 lb/hr of pallets would be $180,000 and would be their model 2400-E with a 150 horsepower motor. The unit would have an electric drive and ram feeder and would process 200 pallets per hour. The outlet particle size would be 2-10". Dave assumed a pallet weight of 50 pounds.

Further Attention Required: Yes ______ No ______ By ______ Date ______



NOTES:
1. FOR QUOTATION PURPOSES ONLY
2. CONTROL PANEL NOT SHOWN
3. (a) RECOMMENDED REMOVAL SPACE
4. (b) CUSTOM DESIGN APPLICATIONS
5. (c) CONSULT FACTORY FOR SPECIAL APPLICATIONS



CUTTING CHAMBER SECTION

MODEL	HP.	OVERALL			CUTTING CHAMBER			STAND		INFEED HOPPER (b)			STANDARD CUTTER THK	OPTIONAL CUTTER THK (c)	WEIGHT (APPROX)
		A	B	C	D	E	F	G	TUBING	H	I	J			
300-E	10/15	83.5	21.25	73.2	20	15.25	8.75	42.5	3 X 3	24	26	24	1"	3/4"	3000
450-E	15/20	88.5	21.25	73.2	24	15.25	8.75	42.5	3 X 3	24	26	32	1"	3/4"	3500
600-E	25/30	107.5	26.25	85.2	30	20.25	10.75	42.5	3 X 3	32	36	39	1 1/4"	3/4"	5000
750-E	30/40	129	33.0	93.0	30	25.0	13.25	43.75	4 X 4	36	42	40	2"	1 1/2", 1"	5500
1000-E	40/50	139	33.0	93.0	40	25.0	13.25	43.75	4 X 4	36	42	50	2"	1 1/2", 1"	6500
1200-E	40/50	149	33.0	93.0	50	25.0	13.25	43.75	4 X 4	36	42	60	2"	1 1/2", 1"	7500
1400-E	50/60	122	42.0	104	40	32.0	17.0	45.0	5 X 5	42	52	42	2"	1 1/2"	6500
1450-E	50/60	132	42.0	104	40	32.0	17.0	45.0	5 X 5	42	52	52	2"	1 1/2"	8000
1500-E	50/60	142	42.0	104	52	32.0	17.0	45.0	5 X 5	42	52	64	2"	1 1/2"	10,000
1600-E	75/100	148	46.0	105.5	50	36.0	16.5	45.0	5 X 5	44	56	62	2"	1 1/2"	12,000
1800-E	75/100	163	46.0	105.5	65	36.0	16.5	45.0	5 X 5	44	56	77	2"	1 1/2"	14,000
2000-E	100/125	148	50.0	112.5	50	40.0	20.5	45.0	5 X 5	47	60	62	2"	——	16,000
2400-E	100/125	158	50.0	112.5	60	40.0	20.5	45.0	5 X 5	47	60	72	2"	——	18,000
3000-E	125/150	185	58.0	114.0	50	45.0	21.0	46.0	6 X 6	47	66	62	2"	——	20,000
3400-E	125/150	210	58.0	114.0	75	45.0	21.0	46.0	6 X 6	47	66	77	2"	——	24,000

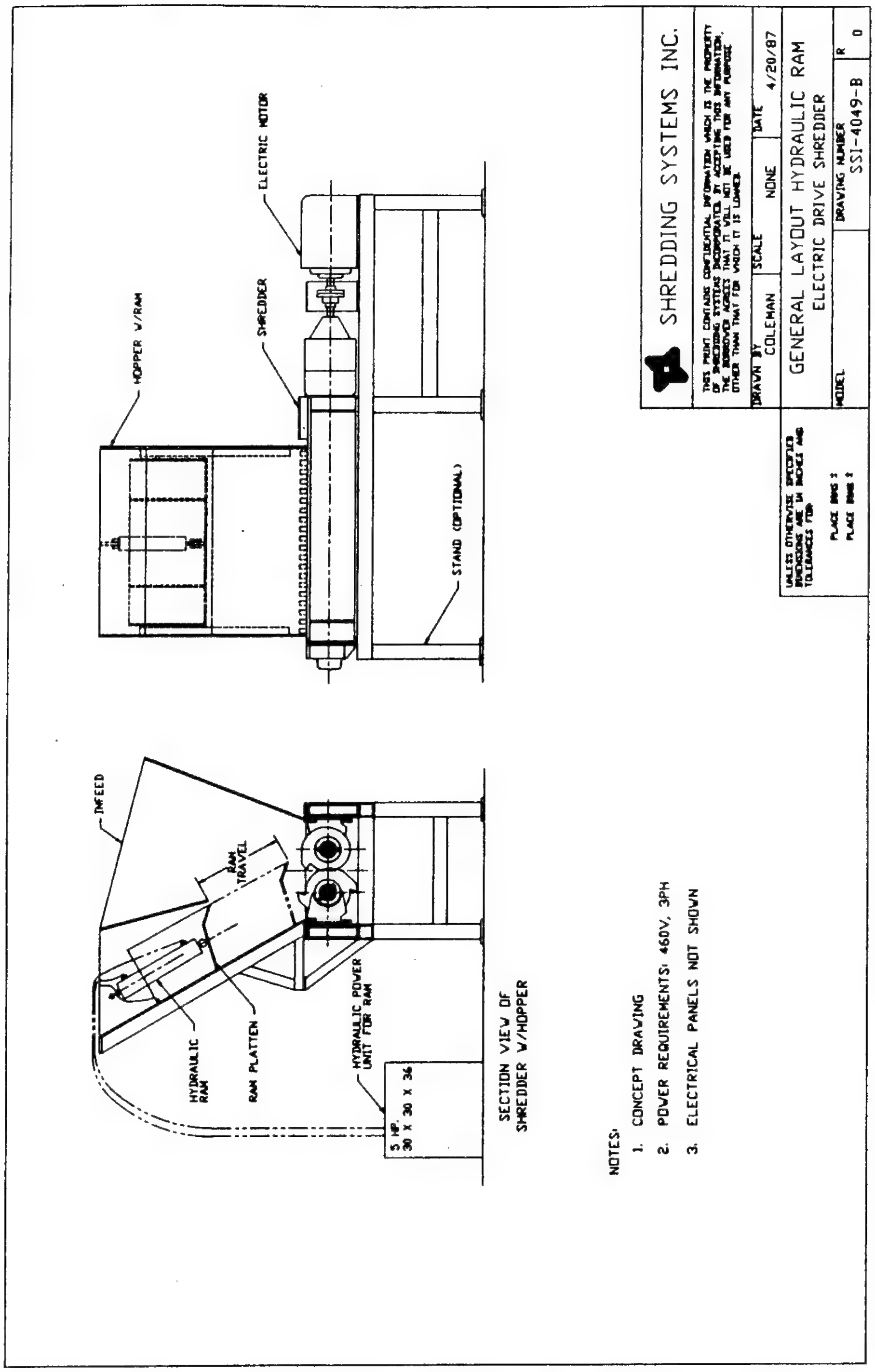
SHREDDING SYSTEMS INC.

THIS PRINT CONTAINS CONFIDENTIAL INFORMATION WHICH IS THE PROPERTY OF SHREDDING SYSTEMS INCORPORATED. BY ACCEPTING THIS INFORMATION, THE BORROWER AGREES THAT IT WILL NOT BE USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS LOANED.

DRAWN BY	SCALE	DATE
COLEMAN	NONE	4/20/87

SINGLE ELECTRIC DRIVE

MODEL	DRAWING NUMBER	R
	SSI-4047-B	2


SHREDDING SYSTEMS INC.
DRAWN BY COLEMAN
SCALE NONE
DATE 4/20/87
GENERAL LAYOUT HYDRAULIC RAM
ELECTRIC DRIVE SHREDDER
DRAWING NUMBER SSI-4049-B
R 0
HOPPER W/RAM
SHREDDER
ELECTRIC MOTOR
STAND (OPTIONAL)
INFEED
RAM TRAVEL
HYDRAULIC RAM
RAM PLATTEN
HYDRAULIC POWER UNIT FOR RAM
5 HP
30 X 30 X 36
SECTION VIEW OF SHREDDER W/HOPPER
NOTES:
1. CONCEPT DRAWING
2. POWER REQUIREMENTS: 460V, 3PH
3. ELECTRICAL PANELS NOT SHOWN

TELEPHONE CALL REPORT

Date: August 16, 1994 Time 9:00 AM Job No. 12172

To: Phil Allen - Elliot Equipment At: Davenport, IA

From: Rich Carroll - SCI At: Muscatine, IA

Subject: Defense Distribution Region East
Central Heating Plant Modernization Study
Roll Off Container System Price

Phil stated that the price for a standard 30 cubic yard roll off container sized eight feet wide, twenty two feet long and five feet high was $3200. A truck with hoist to handle and dump the containers would be $95,000. That price was for a Frieghtliner with a 60,000 pound capacity.

Further Attention Required: Yes ______ No ______ By ____________________ Date ______________

TELEPHONE CALL REPORT

Date: August 15, 1994 Time 4:00 PM Job No. 12172

To: Jerry Sheldon - Martin Equipment At: Rock Island, Illinois

From: Rich Carroll - SCI At: Muscatine, Iowa

Subject: Defense Distribution Region East
Central Heating Plant Modifications
Skid Steer Loader Price

Jerry stated that the price for a Gehl Model 4625, 1200 pound lifting capacity, 63" wide, 45 horsepower would be $21,000. Extra bucket attachments to handle pallets would bring the price to approximately $25,000.

Further Attention Required: Yes ______ No ______ By ____________ Date ____________

SC 5000 R2 1092 (TCR.PRI)

KEITH™ MFG. CO.

WALKING FLOOR® UNLOADER
works like magic

World Headquarters
401 NW Adler
P.O. Box 1
Madras, OR 97741-0001 · USA
503-475-3802
Fax 503-475-2169
National 800-547-6161

Specifications and Quote

August 10, 1994

Mr. Richard Carroll
Stanley Consutants
225 Iowa Ave.
Muscatine, IA 52761

Dear Mr. Carroll:

Following are the specifications and quote you requested:

(1) 10' x 50' **KEITH WALKING FLOOR®** module, equipped as follows:

Drive: (1) model **KRFII**-3.5 one-way drive mechanism; which has (3) 3.5" bore cylinders attached to (3) 2" x 8" x .250" cross drives, each cylinder has (2) pistons, (2) cylinder heads, (2) piston rods, each piston assembly will have (2) piston seals and (1) wear ring, each cylinder head will have (2) rod wipers, (1) rod seal, (2) wear rings, (1) 'O' ring. Each set of cylinders is independently removable and interchangeable.

Flooring: Extrusion #2039, 7" wide, .188" thick #6061T6 aluminum. The floor slat will be attached to the cross drives with (6) (minimum) 3/8" x 1" Allen type countersunk grade 8 bolts with Nylock nuts.

Bearings: The flooring will ride on high density polyethylene bearings which have 15.45 square inches of bearing surface per bearing. The bearings will support the floor slat from the underside of the slat and the legs, on each cross member.

Sub Structure:	The drive mechanism, flooring and bearings will be assembled on a welded sub structure, fabricated out of steel structural members.
Paint:	All steel surfaces will be primed with gray oxide primer and painted with camas gray enamel paint, unless otherwise specified.
Load Rating:	Unit is rated @ 38 tons maximum load. The load rating on the unit is calculated at a maximum material depth of 10' and a density of 15 pcf.

Hydraulic Power Unit:

Motor:	(1) 15 HP Baldor Energy Efficient, TEFC, 1.15 service factor, 3PH, 230/460V motor, (motor starters not included).
Pump:	(1) 13.14 gpm variable volume pressure compensated pump with load sensing.
Filters:	(1) return line filter.
Protection:	(1) float switch.
Tank Heater:	(1) 1.5 KW NEMA 4 tank heater.
Control Panel:	(1) Panel with; (1) motor start/stop switch, (1) floor off/on switch. Control panel to be mounted on the power unit. If PLC operation is desired, price will have to be quoted at a later date, when all desired functions are decided on.
Reservoir:	(1) 45 gallon hydraulic fluid reservoir coated with G.E. Glyptol (hydraulic fluid not included), with oil control lip and test ports. Hydraulic lines from power unit to drive mechanism by others.
Speed:	From .25 - 2.5 fpm.

4

Walls, roof and support structures by other.

For the sum of: $ 38,100.00

All prices quoted are FOB, MADRAS, OREGON. Price good for 60 days.

Terms: 25% down with purchase order, 65% due upon delivery, balance (10%) due 10 days after start up or 60 days after delivery, which ever occurs first.

Thank you for giving us the opportunity to quote you on this project. Should you have any questions or if we can be of any further service, please do not hesitate to give us a call.

Respectfully yours,

Mark Jay Beason
Marketing

Appendix D: Cost Estimates

PROJECT: HEATING PLANT STUDY
LOCATION: CUMBERLAND, PENNSYLVANIA
JOB NO.: 12172-02-652

SHEET 1 OF 1

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY		LABOR & MATERIAL	
		NO. UNITS	UNIT MEAS.	$ PER UNIT	TOTAL
	ALTERNATE NO. 1 – NEW GAS/OIL BOILERS				
	DEMOLITION:				
	BOILER 50,000 #/HR	3	EA	$100,000.00	$300,000
	BOILER 20,000 #/HR	1	EA	$75,000.00	$75,000
	STACKS & FLUES	4	EA	$50,000.00	$200,000
	BUILDING WALL	3000	SF	$10.00	$30,000
	MISCELLANEOUS PIPING, VALVES, HANGERS, ETC.	---	LS	---	$25,000
	MISCELLANEOUS ELECTRICAL WORK	---	LS	---	$10,000
	NEW WORK:				
	BOILER 75,000 #/HR	2	EA	$530,000.00	$1,060,000
	BOILER 20,000 #/HR	1	EA	$117,000.00	$117,000
	GAS LINE TO PLANT	---	LS	---	$1,375,000
	STACKS	3	EA	$10,000.00	$30,000
	BUILDING WALL	3000	SF	$20.00	$60,000
	PIPING, VALVES, HANGERS & INSULATION (FOR BOILERS)	---	LS	---	$100,000
	BOILER CONTROLS & INSTRUMENTS	---	LS	---	$250,000
	PATCH ROOF	---	LS	---	$10,000
	MISCELLANEOUS PIPING, VALVES, ETC.	---	LS	---	$25,000
	MISCELLANEOUS ELECTRICAL WORK	---	LS	---	$30,000
	SUBTOTAL				$3,697,000
	UNDEVELOPED DESIGN DETAILS				$348,300
	OVERHEAD				$400,545
	PROFIT				$267,030
	SUBTOTAL				$4,712,875
	ENGINEERING, ADMINISTRATION & CONTINGENCIES				$942,575
	ESCALATION TO 1996				$565,545
	TOTAL				$6,220,995
	PROBABLE COST USE				$6,221,000
	NOTES: 1) COSTS FOR ASBESTOS REMOVAL ARE NOT INCLUDED 2) COSTS ARE ESCALATED TO 1996				

X PRICES INCLUDE ESCALATION TO 1996
PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	D.R.DRAKE	8/30/94
CHECKER:	J.L.HANSEN	8/30/94
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: HEATING PLANT STUDY
LOCATION: CUMBERLAND, PENNSYLVANIA
JOB NO.: 12172-02-652

SHEET 1 OF 2

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATE NO. 2 – NEW GAS/OIL BOILERS W/ENGINE COGENERATION & ABSORPTION CHILLER IN EDC				
	DEMOLITION:				
	BOILER 50,000 #/HR	3	EA	$100,000.00	$300,000
	BOILER 20,000 #/HR	1	EA	$75,000.00	$75,000
	STACKS & FLUES	4	EA	$50,000.00	$200,000
	BUILDING WALL	3000	SF	$10.00	$30,000
	MISCELLANEOUS PIPING, VALVES, HANGERS, ETC.	---	LS	---	$25,000
	MISCELLANEOUS ELECTRICAL WORK	---	LS	---	$10,000
	NEW WORK:				
	BOILER 75,000 #/HR	2	EA	$530,000.00	$1,060,000
	BOILER 20,000 #/HR	1	EA	$117,000.00	$117,000
	GAS LINE TO PLANT	---	LS	---	$4,000,000
	STACKS	3	EA	$10,000.00	$30,000
	BUILDING WALL	3000	SF	$20.00	$60,000
	PIPING, VALVES, HANGERS & INSULATION (FOR BOILERS)	---	LS	---	$100,000
	BOILER CONTROLS & INSTRUMENTS	---	LS	---	$250,000
	PATCH ROOF	---	LS	---	$10,000
	MISCELLANEOUS PIPING, VALVES, ETC.	---	LS	---	$25,000
	ENGINE GENERATOR	3	EA	$655,000.00	$1,965,000
	COOLING TOWER (FOR ENGINES & CHILLER)	2	EA	$52,000.00	$104,000
	COOLING TOWER FOUNDATION & BASIN	2	EA	$20,000.00	$40,000
	COOLING WATER PUMP 860 GPM, 75' TDH, 25 HP (FOR ENGINES)	3	EA	$9,000.00	$27,000
	COOLING WATER PUMP 1250 GPM, 75' TDH, 30 HP (FOR CHILLER)	2	EA	$10,000.00	$20,000
	ABSORPTION CHILLER 1,000 TON	1	EA	$490,000.00	$490,000
	CHILLER BUILDING	1800	SF	$125.00	$225,000
	COOLING WATER PIPING & INSULATION:				
	12"	160	LF	$150.00	$24,000
	10"	40	LF	$120.00	$4,800
	8"	150	LF	$85.00	$12,750
	VALVING	---	LS	---	$25,000
	CHILLER & COOLING TOWER INSTRUMENTS & CONTROLS	---	LS	---	$60,000
	SUBSTATION MODIFICATIONS	---	LS	---	$50,000
	PLANT TIE IN	---	LS	---	$270,000
	CONDUIT & CABLE:				
	15 & 5 KV	---	LS	---	$50,000
	600V	---	LS	---	$25,000
	MISCELLANEOUS ELECTRICAL WORK, MCC'S, ETC.	---	LS	---	$50,000

TOTAL OF SHEET $9,734,550

X PRICES INCLUDE ESCALATION TO 1996
PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	D.R.DRAKE	8/30/94
CHECKER:	J.L.HANSEN	8/30/94
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: HEATING PLANT STUDY
LOCATION: CUMBERLAND, PENNSYLVANIA
JOB NO.: 12172-02-652

SHEET 2 OF 2

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $.PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATE NO. 2 – NEW GAS/OIL BOILERS W/ENGINE COGENERATION & ABSORPTION CHILLER IN EDC (CONTINUED)				
	SUBTOTAL PREVIOUS SHEET				$9,734,550
	UNDEVELOPED DESIGN DETAILS				$860,183
	OVERHEAD				$989,210
	PROFIT				$659,473
	SUBTOTAL				$12,243,416
	ENGINEERING, ADMINISTRATION & CONTINGENCIES				$2,448,683
	ESCALATION TO 1996				$1,469,210
	TOTAL				$16,161,309
	PROBABLE COST USE				$16,161,000
	NOTES: 1) COSTS FOR ASBESTOS REMOVAL ARE NOT INCLUDED 2) COSTS ARE ESCALATED TO 1996				

X PRICES INCLUDE ESCALATION TO 1996
PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	D.R.DRAKE	8/30/94
CHECKER:	J.L.HANSEN	8/30/94
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: HEATING PLANT STUDY
LOCATION: CUMBERLAND, PENNSYLVANIA
JOB NO.: 12172-02-652

SHEET 1 OF 2

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATE NO. 3 – NEW GAS/OIL BOILERS W/GAS TURBINE COGENERATION & ABSORPTION CHILLER IN EDC				
	DEMOLITION:				
	BOILER 50,000 #/HR	3	EA	$100,000.00	$300,000
	BOILER 20,000 #/HR	1	EA	$75,000.00	$75,000
	STACKS & FLUES	4	EA	$50,000.00	$200,000
	BUILDING WALL	3000	SF	$10.00	$30,000
	MISCELLANEOUS PIPING, VALVES, HANGERS, ETC.	---	LS	---	$25,000
	MISCELLANEOUS ELECTRICAL WORK	---	LS	---	$10,000
	NEW WORK:				
	BOILER 75,000 #/HR	2	EA	$530,000.00	$1,060,000
	BOILER 20,000 #/HR	1	EA	$117,000.00	$117,000
	GAS LINE TO PLANT	---	LS	---	$4,000,000
	STACKS	3	EA	$10,000.00	$30,000
	BUILDING WALL	3000	SF	$20.00	$60,000
	PIPING, VALVES, HANGERS & INSULATION (FOR BOILERS)	---	LS	---	$100,000
	BOILER CONTROLS & INSTRUMENTS	---	LS	---	$250,000
	PATCH ROOF	---	LS	---	$10,000
	MISCELLANEOUS PIPING, VALVES, ETC.	---	LS	---	$25,000
	GAS TURBINE GENERATOR	1	EA	$660,000.00	$660,000
	HEAT RECOVERY STEAM GENERATOR	1	EA	$275,000.00	$275,000
	COOLING TOWER (FOR CHILLER)	1	EA	$52,000.00	$52,000
	COOLING TOWER FOUNDATION & BASIN	1	EA	$20,000.00	$20,000
	COOLING WATER PUMP 1250 GPM, 75' TDH, 30 HP (FOR CHILLER)	2	EA	$10,000.00	$20,000
	ABSORPTION CHILLER 1,000 TON	1	EA	$490,000.00	$490,000
	CHILLER BUILDING	1800	SF	$125.00	$225,000
	COOLING WATER PIPING & INSULATION:				
	12"	80	LF	$150.00	$12,000
	8"	30	LF	$85.00	$2,550
	VALVING	---	LS	---	$10,000
	CHILLER & COOLING TOWER INSTRUMENTS & CONTROLS	---	LS	---	$40,000
	SUBSTATION MODIFICATIONS	---	LS	---	$50,000
	PLANT TIE IN	---	LS	---	$190,000
	CONDUIT & CABLE:				
	15 & 5 KV	---	LS	---	$40,000
	600V	---	LS	---	$25,000
	MISCELLANEOUS ELECTRICAL WORK, MCC'S, ETC.	---	LS	---	$40,000

TOTAL OF SHEET $8,443,550

X PRICES INCLUDE ESCALATION TO 1996
PRICES ARE AS OF DATE OF THIS ESTIMATE

	DATE
ESTIMATOR: D.R.DRAKE	8/30/94
CHECKER: J.L.HANSEN	8/30/94
CONST. MGR.:	

STANLEY CONSULTANTS

PROJECT: HEATING PLANT STUDY
LOCATION: CUMBERLAND, PENNSYLVANIA
JOB NO.: 12172-02-652

SHEET 2 OF 2

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATE NO. 3 – NEW GAS/OIL BOILERS W/GAS TURBINE COGENERATION & ABSORPTION CHILLER IN EDC (CONTINUED)				
	SUBTOTAL PREVIOUS SHEET				$8,443,550
	UNDEVELOPED DESIGN DETAILS				$666,533
	OVERHEAD				$766,512
	PROFIT				$511,008
	SUBTOTAL				$10,387,603
	ENGINEERING, ADMINISTRATION & CONTINGENCIES				$2,077,521
	ESCALATION TO 1996				$1,246,512
	TOTAL				$13,711,636
	PROBABLE COST USE				$13,712,000
	NOTES: 1) COSTS FOR ASBESTOS REMOVAL ARE NOT INCLUDED 2) COSTS ARE ESCALATED TO 1996				

X PRICES INCLUDE ESCALATION TO 1996
PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	D.R.DRAKE	8/30/94
CHECKER;	J.L.HANSEN	8/30/94
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: HEATING PLANT STUDY
LOCATION: CUMBERLAND, PENNSYLVANIA
JOB NO.: 12172-02-652

SHEET 2 OF 2

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATE NO. 4A – NEW GAS/OIL BOILERS W/WASTE WOOD BOILER (CONTINUED)				
	SUBTOTAL PREVIOUS SHEET				$9,772,800
	UNDEVELOPED DESIGN DETAILS				$865,920
	OVERHEAD				$995,808
	PROFIT				$663,872
	SUBTOTAL				$12,298,400
	ENGINEERING, ADMINISTRATION & CONTINGENCIES				$2,459,680
	ESCALATION TO 1996				$1,475,808
	TOTAL				$16,233,888
	PROBABLE COST USE				$16,234,000
	NOTES: 1) COSTS FOR ASBESTOS REMOVAL ARE NOT INCLUDED 2) COSTS ARE ESCALATED TO 1996				

X PRICES INCLUDE ESCALATION TO 1996
PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	D.R.DRAKE	8/30/94
CHECKER:	J.L.HANSEN	8/30/94
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: HEATING PLANT STUDY
LOCATION: CUMBERLAND, PENNSYLVANIA
JOB NO.: 12172-02-652

SHEET 1 OF 2

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY		LABOR & MATERIAL	
		NO. UNITS	UNIT MEAS.	$ PER UNIT	TOTAL
	ALTERNATE NO. 4A – NEW GAS/OIL BOILERS W/WASTE WOOD BOILER				
	DEMOLITION:				
	BOILER 50,000 #/HR	3	EA	$100,000.00	$300,000
	BOILER 20,000 #/HR	1	EA	$75,000.00	$75,000
	STACKS & FLUES	4	EA	$50,000.00	$200,000
	BUILDING WALL	3000	SF	$10.00	$30,000
	MISCELLANEOUS PIPING, VALVES, HANGERS, ETC.	---	LS	---	$25,000
	MISCELLANEOUS ELECTRICAL WORK	---	LS	---	$10,000
	NEW WORK:				
	BOILER 75,000 #/HR	2	EA	$530,000.00	$1,060,000
	BOILER 20,000 #/HR	1	EA	$117,000.00	$117,000
	GAS LINE TO PLANT	---	LS	---	$4,000,000
	STACKS	3	EA	$10,000.00	$30,000
	BUILDING WALL	3000	SF	$20.00	$60,000
	PIPING, VALVES, HANGERS & INSULATION (FOR BOILERS)	---	LS	---	$100,000
	BOILER CONTROLS & INSTRUMENTS	---	LS	---	$250,000
	PATCH ROOF	---	LS	---	$10,000
	MISCELLANEOUS PIPING, VALVES, ETC.	---	LS	---	$25,000
	WASTE WOOD BOILER	---	LS	---	$2,300,000
	LOADER	1	EA	$30,000.00	$30,000
	SHREDDER	1	EA	$216,000.00	$216,000
	WALKING FLOOR	2	EA	$46,000.00	$92,000
	BELT CONVEYOR 36" X 12'	1	EA	$12,000.00	$12,000
	BELT CONVEYOR 36" X 45'	1	EA	$30,000.00	$30,000
	ROLL-OFF CONTAINERS	10	EA	$4,000.00	$40,000
	TRUCK TO HANDLE ROLL-OFF CONTAINERS	1	EA	$95,000.00	$95,000
	BUILDING ADDITION	3410	SF	$100.00	$341,000
	BUILDING ADDITION NOT HEATED	3330	SF	$60.00	$199,800
	CHAIN CONVEYOR	1	EA	$36,000.00	$36,000
	SCREW CONVEYOR	1	EA	$24,000.00	$24,000
	MISCELLANEOUS PIPING, VALVES, ETC. FOR WASTE WOOD BOILER	---	LS	---	$15,000
	MISCELLANEOUS ELECTRICAL WORK, MCC'S, ETC.	---	LS	---	$50,000

TOTAL OF SHEET $9,772,800

X PRICES INCLUDE ESCALATION TO 1996
PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	D.R.DRAKE	8/30/94
CHECKER:	J.L.HANSEN	8/30/94
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: HEATING PLANT STUDY
LOCATION: CUMBERLAND, PENNSYLVANIA
JOB NO.: 12172-02-652

SHEET 1 OF 2

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY		LABOR & MATERIAL	
		NO. UNITS	UNIT MEAS.	$ PER UNIT	TOTAL
	ALTERNATE NO. 4B – NEW GAS/OIL BOILERS W/WASTE WOOD BOILER & ABSORPTION CHILLER IN EDC				
	DEMOLITION:				
	BOILER 50,000 #/HR	3	EA	$100,000.00	$300,000
	BOILER 20,000 #/HR	1	EA	$75,000.00	$75,000
	STACKS & FLUES	4	EA	$50,000.00	$200,000
	BUILDING WALL	3000	SF	$10.00	$30,000
	MISCELLANEOUS PIPING, VALVES, HANGERS, ETC.	---	LS	---	$25,000
	MISCELLANEOUS ELECTRICAL WORK	---	LS	---	$10,000
	NEW WORK:				
	BOILER 75,000 #/HR	2	EA	$530,000.00	$1,060,000
	BOILER 20,000 #/HR	1	EA	$117,000.00	$117,000
	GAS LINE TO PLANT	---	LS	---	$4,000,000
	STACKS	3	EA	$10,000.00	$30,000
	BUILDING WALL	3000	SF	$20.00	$60,000
	PIPING, VALVES, HANGERS & INSULATION (FOR BOILERS)	---	LS	---	$100,000
	BOILER CONTROLS & INSTRUMENTS	---	LS	---	$250,000
	PATCH ROOF	---	LS	---	$10,000
	MISCELLANEOUS PIPING, VALVES, ETC.	---	LS	---	$25,000
	COOLING TOWER (FOR CHILLER)	1	EA	$52,000.00	$52,000
	COOLING TOWER FOUNDATION & BASIN	1	EA	$20,000.00	$20,000
	COOLING WATER PUMP 1250 GPM, 75' TDH, 30 HP (FOR CHILLER)	2	EA	$10,000.00	$20,000
	ABSORPTION CHILLER 1,000 TON	1	EA	$490,000.00	$490,000
	CHILLER BUILDING	1800	SF	$125.00	$225,000
	COOLING WATER PIPING & INSULATION:				
	12"	80	LF	$150.00	$12,000
	8"	30	LF	$85.00	$2,550
	VALVING	---	LS	---	$10,000
	CHILLER & COOLING TOWER INSTRUMENTS & CONTROLS	---	LS	---	$40,000
	VALVING	---	LS	---	$10,000
	CHILLER & COOLING TOWER INSTRUMENTS & CONTROLS	---	LS	---	$40,000
	WASTE WOOD BOILER	---	LS	---	$2,300,000
	LOADER	1	EA	$30,000.00	$30,000
	SHREDDER	1	EA	$216,000.00	$216,000
	WALKING FLOOR	2	EA	$46,000.00	$92,000
	BELT CONVEYOR 36" X 12'	1	EA	$12,000.00	$12,000
	BELT CONVEYOR 36" X 45'	1	EA	$30,000.00	$30,000
	ROLL-OFF CONTAINERS	10	EA	$4,000.00	$40,000
	TRUCK TO HANDLE ROLL-OFF CONTAINERS	1	EA	$95,000.00	$95,000
	BUILDING ADDITION.	3410	SF	$100.00	$341,000
	BUILDING ADDITION NOT HEATED	3330	SF	$60.00	$199,800
	CHAIN CONVEYOR	1	EA	$36,000.00	$36,000
	SCREW CONVEYOR	1	EA	$24,000.00	$24,000
	MISCELLANEOUS PIPING, VALVES, ETC. FOR WASTE WOOD BOILER	---	LS	---	$15,000
	MISCELLANEOUS ELECTRICAL WORK, MCC'S, ETC.	---	LS	---	$50,000

TOTAL OF SHEET $10,694,350

X PRICES INCLUDE ESCALATION TO 1996
PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE

ESTIMATOR:	D.R.DRAKE	8/30/94
CHECKER:	J.L.HANSEN	8/30/94
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: HEATING PLANT STUDY
LOCATION: CUMBERLAND, PENNSYLVANIA
JOB NO.: 12172-02-652

SHEET 2 OF 2

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATE NO. 4B – NEW GAS/OIL BOILERS W/WASTE WOOD BOILER & ABSORPTION CHILLER IN EDC (CONTINUED)				
	SUBTOTAL PREVIOUS SHEET				$10,694,350
	UNDEVELOPED DESIGN DETAILS				$1,004,153
	OVERHEAD				$1,154,775
	PROFIT				$769,850
	SUBTOTAL				$13,623,128
	ENGINEERING, ADMINISTRATION & CONTINGENCIES				$2,724,626
	ESCALATION TO 1996				$1,634,775
	TOTAL				$17,982,529
	PROBABLE COST USE				$17,983,000
	NOTES: 1) COSTS FOR ASBESTOS REMOVAL ARE NOT INCLUDED 2) COSTS ARE ESCALATED TO 1996				

X PRICES INCLUDE ESCALATION TO 1996
PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	D.R.DRAKE	8/30/94
CHECKER:	J.L.HANSEN	8/30/94
CONST. MGR.:		

STANLEY CONSULTANTS

Appendix E: CHPECON Cases

```
*****************************************************************************
**   Central Heating Plant Economics Evaluation Program          Page 1    **
**   File: DDREA1        Type: New plant (NP)                   11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                        **
**   Tech: Gas / Oil Fired Boiler                                           **
*****************************************************************************

State    : PA - Pennsylvania
Location :  40d 13m -  76d 50m
County   :
Emission regulation region
#  2 - Erie, Harrisburg, York, Lancaster, Scranton, Wilkes-Barre

Annual heating degree days:  5335

*************************** Boiler Characteristics ***************************

Type of heating system : Steam

Average Monthly Steam Flows (million Btu/hr)

              Jan      Feb      Mar      Apr      May      Jun
               67       67       56       30
              Jul      Aug      Sep      Oct      Nov      Dec
                                          16       49       65

Calculated PMCR:  86 thousand lb/hr steam

Boiler technology: Gas / Oil Fired Boiler

Boiler sizes (thousand lb steam/hr) :
         1:  29     2:  29     3:  29

Fuel Oil #2 composition - weight basis
    87.40 % Carbon     12.50 % Hydrogen            0.00 % Oxygen
     0.00 % Nitrogen    0.10 % Sulfur              0.00 % Ash
     0.00 % Moisture
      18993 Btu/lb heating value
   0.856 Specific gravity

Boiler Operating Parameters -- Fuel Oil #2
   Combustion air temp:  70 deg F      30 % relative humidity
   Flue gas temp: 350 deg F          2.50 % oxygen (dry basis)
   50.02 % combustibles
   13.69 % CO2                      83.79 % N2
   0.00481 lb/lb dry air            0.00772 mole/mole dry air
    12.65 % excess air              0.020 % combustibles

Boiler Performance -- Fuel Oil #2
   Sensible dry gas loss:         5.775 %    Loss H2O vapor in air:       0.048 %
   Fuel H2O heat loss:            0.000 %    H2 comb H2O heat loss:       6.993 %
   Radiation heat loss:           2.166 %    Unaccounted for loss:        1.000 %
   Combustible gas heat loss:     0.068 %
   Boiler efficiency:            83.950 %
```

```
******************************************************************************
**   Central Heating Plant Economics Evaluation Program          Page 2     **
**   File: DDREA1        Type: New plant (NP)                    11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                        **
**   Tech: Gas / Oil Fired Boiler                                           **
******************************************************************************

Fuel Oil #6 composition - weight basis
    88.73 % Carbon      9.33 % Hydrogen             0.70 % Oxygen
     0.30 % Nitrogen    0.70 % Sulfur               0.04 % Ash
     0.20 % Moisture
      18126 Btu/lb heating value
   0.972 Specific gravity

Boiler Operating Parameters -- Fuel Oil #6
   Combustion air temp:  70 deg F      30 % relative humidity
   Flue gas temp: 350 deg F          2.50 % oxygen (dry basis)
   50.02 % combustibles
   14.70 % CO2                      82.78 % N2
   0.00481 lb/lb dry air            0.00772 mole/mole dry air
    12.65 % excess air              0.020 % combustibles

Boiler Performance -- Fuel Oil #6
   Sensible dry gas loss:      5.749 %   Loss H2O vapor in air:       0.048 %
   Fuel H2O heat loss:         0.013 %   H2 comb H2O heat loss:       5.469 %
   Radiation heat loss:        2.166 %   Unaccounted for loss:        1.000 %
   Combustible gas heat loss:  0.067 %
   Boiler efficiency:         85.487 %

************************* Boiler Performance @ PMCR **************************
Blowdown    :    5 %

Temperature out of stack :   350 deg F
Steam pressure           :  150 psig
Steam temperature        :  367 deg F        enthalpy  : 1195.6 Btu/lb
Condensate return temp   :  150 deg F        enthalpy  :  118.0 Btu/lb
Makeup water temperature :   50 deg F        enthalpy  :   18.0 Btu/lb
Inlet water temperature  :  125 deg F        enthalpy  :   92.8 Btu/lb

********************* Area and Water Requirements @ PMCR *********************

Building size :  6500 sq ft            Condensate Return     :    80 %
Plant area    :  1.04 acres            Boiler house leakage  :     2 %
Plant height  :    40 ft               Water requirements    :   100 gpm (est)
Stack height  :    60 ft               Railway track length  :   125 ft
Sewer dischrg :    25 gpm (est)
```

```
*******************************************************************************
**   Coal Fired Boiler Evaluation Program                         Page 3     **
**   File: DDREA1        Type: New plant (NP)                    11/09/94    **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                         **
**   Tech: Gas / Oil Fired Boiler                                            **
*******************************************************************************

************************ General Site Considerations *************************
```

Development and Construction

Contractors ARE AVAILABLE for CHP construction near the base. The availability of contractors in the neighborhood of the base will ensure the overall cost of the facility will be kept at a minimum.
  Score: 5

Asbestos IS NOT PRESENT around the pipelines for the CHP. No special handling or disposal is required.
  Score: 5

The site IS CAPABLE of supporting the building and equipment foundation. No additional costs would be incurred for the construction of a CHP.
  Score: 5

The site WILL NOT REQUIRE special cleanup. No additional costs would be incurred for the construction of a CHP.
  Score: 5

The site IS ACCESSIBLE by construction personnel and equipment. No special arrangements are required.
  Score: 5

The soil DOES MEET THE REQUIREMENTS for minimizing wastewater seepage. No additional costs are expected for control measures.
  Score: 5

There IS SUFFICIENT LEVEL GROUND for the CHP facility. No additional costs are expected in this area.
  Score: 5

There IS ADEQUATE UTILITY ACCESS for the CHP facility connections. No additional costs are expected in this area.
  Score: 5

There ARE NO TERRAIN (UNDERGROUND) CONSIDERATIONS for the CHP facility. No additional costs are expected in this area.
  Score: 5

There IS SUFFICIENT CONSTRUCTION STORAGE AREA for wastes from the CHP facility. No additional costs are expected in this area.
  Score: 5

The site IS FREE OF INFRASTRUCTURE CONSTRAINTS. No additional costs are expected in this area.
  Score: 5

```
*****************************************************************************
**   Central Heating Plant Economics Evaluation Program           Page 4    **
**   File: DDREA1         Type: New plant (NP)                    11/09/94  **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                        **
**   Tech: Gas / Oil Fired Boiler                                           **
*****************************************************************************
```

There IS NO CONSTRUCTION INTERFERING WITH CHP facility construction. No additional costs are expected in this area.
Score: 5

There ARE STAFF AVAILABLE FOR COORDINATION of construction activities. No additional costs are expected in this area.
Score: 5

There IS NOT A PROBLEM (OR POTENTIAL) WITH FLOODING. No additional costs are expected in this area.
Score: 5

There ARE ADEQUATE STORAGE SITES for accepting material removed during construction. No additional costs are expected in this area.
Score: 5

The site IS LOCATED in a stable region. No problems can be expected with regard to earthquakes or other seismic disturbances to buildings or foundations.
Score: 5

There IS NO ASBESTOS present. No additional costs are expected to be incurred in this area.
Score: 5

Conditions DO NOT DIFFER materially from conditions ordinarily encountered. No additional costs are expected in this area.
Score: 5

Adequate sources of construction material ARE AVAILABLE. No additional costs are expected in this area.
Score: 5

There MAY BE REGULATIONS that will affect zoning. This should be verified because the additional cost related to zoning problems are not considered in the CHPEcon cost model.
Score: 2

STAFF ARE AVAILABLE to supervise construction. No additional costs are expected in this area.
Score: 5

There IS NO REMOVAL SCHEDULE that relies upon CHP construction. No additional costs are expected in this area.
Score: 5

```
******************************************************************************
**   Central Heating Plant Economics Evaluation Program              Page 5  **
**   File: DDREA1        Type: New plant (NP)                      11/09/94  **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                         **
**   Tech: Gas / Oil Fired Boiler                                            **
******************************************************************************

     Total:    586/  595      98%

==============================================================================


Fuel Supply and Site Access

Gas purchase contracts: none
  Score:    0

A LONG-TERM OIL TRUCKING CONTRACT can be established.  This type
of contract is dependent on the trucking company's contract with
the supplier, and is potentially costlier and less stable.
  Score:    4

There ARE NO SPECIAL SETUPS required for site access.  No
additional costs are expected in this area.
  Score:    5

     Total:     60/  120      50%

==============================================================================


Ecology

Endangered species ARE NOT PRESENT on the site.  No additional
costs are expected in this area.
  Score:    5

There IS NO POTENTIAL for local resident opposition.  No
additional costs are expected in this area.
  Score:    5

The facility IS NOT LOCATED near areas sensitive to acid rain.
No additional costs are expected in this area (in the absence of
new air emissions regulations).
  Score:    5

There IS NO POTENTIAL IMPACT from soil / shore erosion.  No
additional costs are expected in this area.
  Score:    5

There area IS NOT PART of a protected wetlands.  No additional
costs are expected in this area.
  Score:    5
```

```
******************************************************************************
**   Central Heating Plant Economics Evaluation Program          Page 6     **
**   File: DDREA1        Type: New plant (NP)                    11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                        **
**   Tech: Gas / Oil Fired Boiler                                           **
******************************************************************************

     Total:    215/  215     100%

==============================================================================
```

Social Considerations

There ARE NOT SITES of significance nearby. No additional costs are expected in this area.
Score: 5

There ARE NO SPECIAL SITES nearby that would interfere with the CHP. No additional costs are expected in this area.
Score: 5

Water contamination MAY BE A MAJOR ISSUE in the community. This should be verified because the additional costs required to overcome or address these issues are not considered in the CHPEcon cost model.
Score: 2

There ARE NO REGULATIONS concerning ambient noise. The additional costs to reduce or overcome noise limitations are not considered in the CHPEcon cost model.
Score: 5

There ARE NO NEIGHBORS that limit CHP placement. No additional costs are expected in this area.
Score: 5

Sufficient room IS AVAILABLE to insure compliance with noise regulations. No additional costs are expected in this area.
Score: 5

The area planned for the CHP IS NOT A CULTURAL RESOURCE. No additional costs are expected in this area.
Score: 5

Construction projects HAVE BEEN SUCCESSFUL. No additional costs are expected in this area.
Score: 5

The community economic situation IS CONDUCIVE to the start of a large construction project offering local jobs. No additional costs are expected in this area.
Score: 5

```
******************************************************************************
**   Central Heating Plant Economics Evaluation Program              Page 7   **
**   File: DDREA1        Type: New plant (NP)                       11/09/94  **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                          **
**   Tech: Gas / Oil Fired Boiler                                             **
******************************************************************************

     Total:    278/  305      91%

==============================================================================
```

Facility Services

Condition of system is good
  Score: 5

Steam distribution system routing is medium
It may be difficult to incorporate the existing distribution system into the new plant. Additional costs may be required heavily modify the existing distribution system. These costs are not considered in the new plant detailed evaluation section of this program.
  Score: 2

City water available: Yes
  Score: 5

There IS DIRECT ACCESS to transmission lines for the delivery of electricity to the CHP. No additional costs are expected in this area.
  Score: 5

There IS TRAINED STAFF available for instrumentation calibration and maintenance of the proposed CHP. No additional costs are expected in this area.
  Score: 5

New electrical substation required: No
  Score: 5

The existing facility's distribution system WILL BE ABLE TO UTILIZE the new CHP steam output without modification. No additional costs are expected in this area.
  Score: 5

There IS ADEQUATE TRAFFIC CONTROL supplied by the existing facilities. No additional costs are expected in this area.
  Score: 5

The current staff IS UTILIZING WRITTEN procedures and operating the existing facility in such a fashion that the addition of the proposed CHP will be incorporated smoothly. No additional costs are expected in this area.
  Score: 5

```
*******************************************************************************
**   Central Heating Plant Economics Evaluation Program              Page 8   **
**   File: DDREA1         Type: New plant (NP)                     11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                          **
**   Tech: Gas / Oil Fired Boiler                                             **
*******************************************************************************
```

Total: 250/ 280 89%

==

Waste Handling and Emissions

There IS ONE OR MORE OUTSIDE AGENCIES with sites that are or can be used for landfill of the collected ash. No additional costs are expected in this area.
Score: 5

Local sewer system available: Yes
Score: 5

Ash and other discharges from the CHP WILL NOT BE classified as hazardous wastes. No additional costs are expected in this area.
Score: 5

Blowdown water and other wastewater CAN BE DELIVERED DIRECTLY to a sewer system. No additional costs are expected in this area.
Score: 5

Other pollutant-emitting plants ARE NOT PRESENT in the surrounding vicinity. No additional costs are expected in this area.
Score: 5

There MAY BE A POSSIBILITY for generating air emissions credits. This should be verified because this represents a potential revenue gain for the facility that is not considered in the CHPEcon cost model.
Score: 2

There MAY BE LOCAL REGULATIONS regarding waste handling and disposal. This should be verified because the additional costs for handling and disposing of waste created by these regulations are not considered in the CHPEcon cost model.
Score: 2

Total: 231/ 255 90%

==

Military

```
*****************************************************************************
**   Central Heating Plant Economics Evaluation Program            Page 9   **
**   File: DDREA1          Type: New plant (NP)                   11/09/94  **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                        **
**   Tech: Gas / Oil Fired Boiler                                           **
*****************************************************************************
```

The base MAY HAVE SECURE ACCESS to fuel supplies. This should be verified because the additional costs for developing a secure and reliable fuel supply are not considered in the CHPEcon cost model.
  Score: 2

Outside contractor operations WILL NOT AFFECT base security. No additional costs are expected in this area.
  Score: 5

Construction WILL NOT AFFECT base security. No additional costs are expected in this area.
  Score: 5

A change in base mission is NOT LIKELY. No additional costs are expected in this area.
  Score: 5

Current base activities WILL NOT INTERFERE with plant construction. No additional costs are expected in this area.
  Score: 5

     Total: 170/ 200   85%

==

```
******************************************************************************
**   Central Heating Plant Economics Evaluation Program          Page 10    **
**   File: DDREA1        Type: New plant (NP)                    11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                         **
**   Tech: Gas / Oil Fired Boiler                                            **
******************************************************************************
```

General Questions Summary

	Total	Max	Rating
Development and Construction	586	595	98
Fuel Supply and Site Access	60	120	50
Ecology	215	215	100
Social Considerations	278	305	91
Facility Services	250	280	89
Waste Handling and Emissions	231	255	90
Military	170	200	85

Boiler technology rating: 10

Feasibility score: 10/10 = 100%

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 1
File: DDREA1          Type: New plant (NP)                                11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Base and Plant Information
******************************************************************************

State: PA - Pennsylvania          Base DOE Region: 1
PMCR:  86,000 lb/hr steam       Number of boilers: 3

Height of the plant: 40 ft
Building area: 6500 sq ft
Plant area: 1.04 acres

******************************************************************************
   Facility Parameters
******************************************************************************

Capital Equipment Escalation Factor:  1.102 (5032.16/1994)
Non-Labor Operation & Maintenance Escalation Factor:  1.092 ( 935.60/1994)
Operation & Maintenance Labor Escalation Factor:  1.119 (4626.82/1994)
Construction Labor Escalation Factor:  1.024 ( 271.10/1994)

Annual electricity usage: 751,784 kW-hr

1994 cost for distillate:  0.695 $/gallon
1994 cost for residual:  0.610 $/gallon
1994 cost for natural gas:  4.320 $/million Btu
1994 cost for electricity:  0.058 $/kW-hr

Annual Facility Output: 253,680 thousand lb steam
Annual #6 Fuel Oil Usage: 2,225 10^3 gal
Heating plant efficiency: 85.5% #6 fuel oil
Year of Study: 1994
Years of Operation: 1998 - 2022
Annual #2 Fuel Oil Usage: 2,456 10^3 gal
Heating plant efficiency: 84.0% #2 fuel oil

******************************************************************************
   Facility Capital Costs
******************************************************************************
```

Equipment		Cost	Equipment		Cost
Boiler:	$	995,926	Stack:	$	34,709
Building/service:	$	990,945	Water trtmnt:	$	188,681
Feedwtr pmps:	$	16,786	Cond xfr pmps:	$	13,718
Cond strg tnk:	$	5,511	Oil (long) storage:	$	177,747
Oil day strg pmp:	$	4,627	Oil heaters:	$	4,848
Oil day strg tanks:	$	15,036	Oil unload pumps:	$	14,544
Oil xfr pmps:	$	4,462	Fire protection:	$	44,075
Cont bldn tnk:	$	787	Intr bldn tnk:	$	787
Compressor:	$	27,196	Car puller:	$	22,037
Rail:	$	11,707	Site preparation:	$	2,864
Site improvements:	$	157,569	Mobile equipment:	$	42,973
Elec substation:	$	58,700	Electrical:	$	120,855

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 2
File: DDREA1       Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*****************************************************************************
   Facility Capital Costs, cont
*****************************************************************************

Piping:              $        684,845    Instrumentation:     $        253,220
Direct costs:        $      1,373,212
*****************************************************************
Plant installed cost:  $       5,696,335

*****************************************************************************
   Facility Annual O & M and Energy Costs
*****************************************************************************

Operating staff: 10
Annual Labor Costs: $ 514,498
Annual Year Non-Labor O & M Costs : $      586,182
1998 #6 fuel oil costs  : $   1,662,186
1998 Auxiliary Energy Costs      : $       44,664
1998 #2 fuel oil costs  : $   1,953,393

*****************************************************************************
   Periodic Major Maintenance Cost Summary
*****************************************************************************

Time Interval          Cost              Time Interval          Cost
-----------------------------            -----------------------------
3 years           $     30,000           5 years           $      6,122
10 years          $     59,691           15 years          $     66,471
18 years          $      5,488           20 years          $     12,862

*****************************************************************************
   Facility Life Cycle Cost Summary
*****************************************************************************

Analysis using #6 fuel oil as primary fuel
+ PV 'Adjusted' Investment Costs                           = $    5,064,021
+ PV Energy + Transportation Costs                         = $   31,337,353
+ PV Annually Recurring O&M Costs                          = $    8,126,830
+ PV Non-Annually Recurring Repair & Replacement           = $      246,468
+ PV Disposal Cost of Existing System                      = $            0
+ PV Disposal Cost of New/Retrofit Facility                = $            0
                                                           ------------------
Total Life Cycle Cost (1994)                               = $   44,774,673

Levelized Cost of Service (1998 start)              = 11.054 $/MMBtu
Levelized Cost of Service (1998 start)              = 13.217 $/1000 lb steam

*****************************************************************************
   Facility Life Cycle Cost Summary
*****************************************************************************

Analysis using #2 fuel oil as primary fuel
+ PV 'Adjusted' Investment Costs                           = $    5,064,021
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 3
File: DDREA1        Type: New plant (NP)                                11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Facility Life Cycle Cost Summary, cont
******************************************************************************

+ PV Energy + Transportation Costs                        = $  34,866,489
+ PV Annually Recurring O&M Costs                         = $   8,126,830
+ PV Non-Annually Recurring Repair & Replacement          = $     246,468
+ PV Disposal Cost of Existing System                     = $           0
+ PV Disposal Cost of New/Retrofit Facility               = $           0
                                                          ------------------
Total Life Cycle Cost (1994)                              = $  48,303,810

Levelized Cost of Service (1998 start)               = 11.926 $/MMBtu
Levelized Cost of Service (1998 start)               = 14.259 $/1000 lb steam
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 1
File: DDREA1        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Base Information
******************************************************************************

State: PA - Pennsylvania            Base DOE Region: 1
PMCR:  86,000 lb/hr steam         Number of boilers: 3

Steam Properties:  150 psi   (1195.6 Btu/lb)
Inlet water temp: 125 deg F      enthalpy:   92.8 Btu/lb

******************************************************************************
   Boiler Design Parameters
******************************************************************************

A mixed bed for condensate polishing IS NOT NEEDED
A dealkalizer unit IS INCLUDED
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis     Page 2
File: DDREA1        Type: New plant (NP)                               11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Plant Design Parameters --- Space Requirements
******************************************************************************

Height of the plant: 40 ft
Building area: 6500 sq ft
Plant area: 1.04 acres

******************************************************************************
   Plant Design Parameters --- Water & Water Treatment Specifications
******************************************************************************

Number of deaerators: 1
Number of resin vessels / train: 1
Number of mixed beds / train: 0
Boiler 1: 1 motor-driven feedwater pump -- 56 gpm
Boiler 2: 1 motor-driven feedwater pump -- 56 gpm
Boiler 3: 1 motor-driven feedwater pump -- 56 gpm
Number of condensate transfer pumps: 3
Condensate transfer pump size: 682 gpm

Condensate storage tank size: 2760 gallons
Number of long term oil storage tanks: 1
Capacity of one long term oil storage tank: 502000 gal
Number of oil (day storage) pumps: 3
Short term storage tank size: 2,784 gallons

Length of rail track: 125 ft
Annual personnel water use: 89,162 gallons
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 3
File: DDREA1       Type: New plant (NP)                                11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Facility Capital Costs
******************************************************************************

Boiler capital costs: $ 995,926
  Boiler #1 ( 29 k-lb stm/hr) cost: $ 331,975
  Boiler #2 ( 29 k-lb stm/hr) cost: $ 331,975
  Boiler #3 ( 29 k-lb stm/hr) cost: $ 331,975

Stack capital costs: $ 34,709

Building and service capital costs: $ 990,945
  Boiler house capital costs: $ 895,280
  Miscellaneous building costs: $ 95,664

Boiler Water Treatment System Capital Costs: $ 188,681
  Cost of zeolite softeners: $ 15,514
  Cost of dealkalizers: $ 101,706
  Cost of chemical injection skid: $ 22,037
  Cost of water lab: $ 22,037
  Cost of 1 deaerator: $ 27,385

Cost of boiler feedwater pumps: $ 16,786
Cost of condensate transfer pumps: $ 13,718

Cost of condensate storage tank: $ 5,511
Cost of long term oil storage: $ 177,747
  Cost of long term storage tanks: $ 142,942
  Cost of long term storage-other: $ 34,805

Cost of oil (day storage) pumps: $ 4,627
Cost of oil (day storage) heaters: $ 4,848
Cost of short term storage tanks: $ 15,036

Cost of oil unloading pumps: $ 14,544
Cost of [3] oil transfer pumps: $ 4,462
Cost of fire protection equipment: $ 44,075
Cost of 1 continuous blowdown tank: $ 787
Cost of 1 intermittent blowdown tank: $ 787
Compressor cost (2 - 30 Hp - 150 psig): $ 27,196

Cost of car puller and accessories: $ 22,037
Cost of rail tracks: $ 11,707

Site preparation cost: $ 2,864
Site improvement cost: $ 157,569

Total cost of mobile equipment: $ 42,973
  Cost of fork lift: $ 22,037
  Cost of pickup truck: $ 15,426
  Cost of power sweeper: $ 5,509

Cost of electric substation: $ 58,700
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 4
File: DDREA1         Type: New plant (NP)                               11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Facility Capital Costs, cont
******************************************************************************

Electrical costs: $ 120,855

Piping costs: $ 684,845

Instrumentation costs: $ 253,220

Spare parts cost: $ 23,480

Initial consumables: $ 8,218

Tools cost: $ 22,037
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 5
File: DDREA1          Type: New plant (NP)                              11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Direct Costs
******************************************************************************

Direct costs: $ 1,373,212
  Development permit cost: $ 58,700
  Project contingency costs: $ 416,193
  Construction management costs: $ 194,223
  Engineering and design costs: $ 332,954
  Owner management costs: $ 166,477
  Startup cost: $ 204,663


******************************************************************************
   Installed Capital Equipment Cost Summary
******************************************************************************

Total Capital Costs: $ 3,070,814
Total Direct labor cost: $ 701,011
Total Freight cost: $ 59,067
Total Bulk material cost: $ 492,229
Total Direct costs: $ 1,373,212

Plant installed cost: $ 5,696,335
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 6
File: DDREA1        Type: New plant (NP)                                11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Facility Operating Labor Requirements
******************************************************************************

Operation personnel requirements
     plant manager: 1
     plant engineer: 0
     plant technician: 0
     plant clerk: 0
     plant secretary: 0
     plant janitor: 0
     operations operator: 4
     operations assistant operator: 1
     fuel storage operator equipment: 0
     maintenance a mechanic: 1
     maintenance a electrician: 1

Operating staff: 10

Annual Labor Costs: $ 514,498
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 7
File: DDREA1        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Yearly O & M Costs Summary
*******************************************************************************

Annual boiler maintenance costs: $ 6,971
Annual insurance cost: $ 98,445
Maximum electrical consumption @ PMCR: 244 kW
  Annual electricity usage: 751,784 kW-hr
Annual O & M (materials/supplies) costs: $ 31,686
  Annual condensate make-up water cost: $ 18,234
  Annual blowdown make-up water cost: $ 4,558
  Annual facility washdown water cost: $ 2,340
  Annual personnel water cost: $ 267
  Annual zeolite softener water cost: $ 3,216
  Annual chemicals cost: $ 626
  Annual sanitary sewer cost: $ 2,443
Annual miscellaneous maintenance costs: $ 7,985
Study year water cost: $3.00/1000 gallon
1994 cost for distillate:  0.695 $/gallon
1994 cost for residual:  0.610 $/gallon
1994 cost for natural gas:  4.320 $/million Btu
1994 cost for electricity:  0.058 $/kW-hr
  Annual consumables cost: $ 1,643
  Annual spare parts cost: $ 3,522
  Annual mobile equipment maintenance: $ 3,437
1998 #6 fuel oil costs  : $   1,662,186
1998 Auxiliary Energy Costs       : $      44,664
1998 #2 fuel oil costs  : $   1,953,393
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 8
File: DDREA1        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Periodic Maintenance Costs Summary
******************************************************************************

Major boiler maintenance costs (every 15 years): $ 59,755
Major stack maintenance costs (every 10 years): $ 6,941
Major water treatment system maintenance costs (every 10 years): $ 52,749
Major deaerator maintenance costs (every 20 years): $ 6,846
Motor-driven feedwater pumps maint costs (every 15 years): $ 6,714
Centrifugal pump maint costs (every 18 years): $ 5,487
Sump pump maintenance costs (every 20 years): $ 6,016
Oil pump maintenance costs (every 5 years): $ 6,122
Periodic EPA permit testing/renewal costs (every 3 years): $ 30,000
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 9
File: DDREA1        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Economic Data Summary
******************************************************************************

Capital Equipment Escalation Factor:  1.102
     based on Engineering News Record, Construction Cost Index: 5032.16

Non-Labor Operation & Maintenance Escalation Factor:  1.092
     based on Chemical Engineering, M & S Index, Steam Power Comp:  935.60

Operation & Maintenance Labor Escalation Factor:  1.119
     based on Engineering News Record, Skilled Labor Index: 4626.82

Construction Labor Escalation Factor:  1.024
     based on Chemical Engineering, Construction Labor Index:  271.10

Annual Facility Output: 253,680 thousand lb steam
Steam enthalpy:         1195.6 Btu/lb
Inlet enthalpy:           92.7 Btu/lb
Annual #6 Fuel Oil Usage: 2,225 10^3 gal
Heating plant efficiency: 85.5% #6 fuel oil
Discount Rate: 4 %
Year of Study: 1994
Years of Operation: 1998 - 2022
10% Investment Cost Exclusion IS NOT applied
Annual #2 Fuel Oil Usage: 2,456 10^3 gal
Heating plant efficiency: 84.0% #2 fuel oil
```

Central Heating Plant Economics Evaluation Program -- Cost Analysis Page 10
File: DDREA1 Type: New plant (NP) 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

Cash Flow Summary

Analysis using #6 fuel oil as primary fuel

1997 adjusted investment: 5,696,335 existing plant salvage: 0

Year	Boiler Fuel	Auxiliary Energy	Non-Energy O&M	Repair and Replacement
1998	1,662,186	44,664	569,745	0
1999	1,746,301	45,167	586,182	0
2000	1,830,403	46,005	586,182	30,000
2001	1,902,506	46,787	586,182	0
2002	1,966,587	47,011	586,182	6,122
2003	2,022,654	47,346	586,182	30,000
2004	2,066,724	47,793	586,182	0
2005	2,114,781	48,407	586,182	0
2006	2,154,839	48,798	586,182	30,000
2007	2,198,897	49,273	586,182	65,813
2008	2,234,944	49,301	586,182	0
2009	2,274,989	49,497	586,182	30,000
2010	2,315,047	50,363	586,182	0
2011	2,356,633	50,670	586,182	0
2012	2,398,230	50,981	586,182	102,593
2013	2,439,815	51,295	586,182	0
2014	2,481,399	51,614	586,182	0
2015	2,522,982	51,935	586,182	35,488
2016	2,564,579	52,260	586,182	0
2017	2,606,164	52,589	586,182	78,675
2018	2,640,823	52,899	586,182	30,000
2019	2,675,481	53,212	586,182	0
2020	2,710,139	53,530	586,182	0
2021	2,744,786	53,852	586,182	30,000
2022	2,779,444	54,177	586,182	6,122

2023 new plant salvage: 0

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis     Page 11
File: DDREA1        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Life Cycle Cost Summary
*******************************************************************************

Analysis using #6 fuel oil as primary fuel
+ PV 'Adjusted' Investment Costs                      = $    5,064,021
+ PV Energy + Transportation Costs                    = $   31,337,353
+ PV Annually Recurring O&M Costs                     = $    8,126,830
+ PV Non-Annually Recurring Repair & Replacement      = $      246,468
+ PV Disposal Cost of Existing System                 = $            0
+ PV Disposal Cost of New/Retrofit Facility           = $            0

                                                      -----------------

Total Life Cycle Cost (1994)                          = $   44,774,673

Levelized Cost of Service (1998 start)           = 11.054 $/MMBtu
Levelized Cost of Service (1998 start)           = 13.217 $/1000 lb steam
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis     Page 12
File: DDREA1        Type: New plant (NP)                                11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*****************************************************************************
   Cash Flow Summary
*****************************************************************************

Analysis using #2 fuel oil as primary fuel
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
1997 adjusted investment:   5,696,335    existing plant salvage:          0
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

Year	Boiler Fuel	Auxiliary Energy	Non-Energy O&M	Repair and Replacement
1998	1,953,393	44,664	569,745	0
1999	2,029,923	45,167	586,182	0
2000	2,106,469	46,005	586,182	30,000
2001	2,169,691	46,787	586,182	0
2002	2,226,257	47,011	586,182	6,122
2003	2,276,185	47,346	586,182	30,000
2004	2,319,442	47,793	586,182	0
2005	2,362,700	48,407	586,182	0
2006	2,399,300	48,798	586,182	30,000
2007	2,435,901	49,273	586,182	65,813
2008	2,475,848	49,301	586,182	0
2009	2,512,448	49,497	586,182	30,000
2010	2,539,068	50,363	586,182	0
2011	2,584,677	50,670	586,182	0
2012	2,630,286	50,981	586,182	102,593
2013	2,675,911	51,295	586,182	0
2014	2,721,519	51,614	586,182	0
2015	2,767,129	51,935	586,182	35,488
2016	2,812,737	52,260	586,182	0
2017	2,858,346	52,589	586,182	78,675
2018	2,896,359	52,899	586,182	30,000
2019	2,934,371	53,212	586,182	0
2020	2,972,382	53,530	586,182	0
2021	3,010,396	53,852	586,182	30,000
2022	3,048,393	54,177	586,182	6,122

```
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
2023 new plant salvage:            0
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 13
File: DDREA1       Type: New plant (NP)                                  11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Life Cycle Cost Summary
******************************************************************************

Analysis using #2 fuel oil as primary fuel
+ PV 'Adjusted' Investment Costs                          = $   5,064,021
+ PV Energy + Transportation Costs                        = $  34,866,489
+ PV Annually Recurring O&M Costs                         = $   8,126,830
+ PV Non-Annually Recurring Repair & Replacement          = $     246,468
+ PV Disposal Cost of Existing System                     = $           0
+ PV Disposal Cost of New/Retrofit Facility               = $           0

                                                          -----------------

Total Life Cycle Cost (1994)                              = $  48,303,810

Levelized Cost of Service (1998 start)               = 11.926 $/MMBtu
Levelized Cost of Service (1998 start)               = 14.259 $/1000 lb steam
```

```
******************************************************************************
**   Central Heating Plant Economics Evaluation Program            Page 1   **
**   File: DDREA2        Type: New plant (NP)                      11/09/94 **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                        **
**   Tech: Gas / Oil Fired Boiler                                           **
******************************************************************************

State    : PA - Pennsylvania
Location :  40d 13m -  76d 50m
County   :
Emission regulation region
#  2 - Erie, Harrisburg, York, Lancaster, Scranton, Wilkes-Barre

Annual heating degree days:  5335

************************** Boiler Characteristics **************************

Type of heating system : Steam

Average Monthly Steam Flows (million Btu/hr)

              Jan      Feb      Mar      Apr      May      Jun
               67       67       56       30
              Jul      Aug      Sep      Oct      Nov      Dec
                                          16       49       65

Calculated PMCR:  86 thousand lb/hr steam      *** October - March basis

Boiler technology: Gas / Oil Fired Boiler

Boiler sizes (thousand lb steam/hr) :
         1:  29     2:  29     3:  29

Natural gas composition - volume basis
    83.40 % Methane        0.00 % Ethylene      15.80 % Ethane
     0.00 % Propane        0.00 % Butane         0.00 % Hydrogen
     0.80 % Nitrogen       0.00 % Oxygen         0.00 % Hydrogen Sulfide (H2S)
     0.00 % Carbon Monoxide (CO)                 0.00 % Carbon Dioxide (CO2)
     1129 Btu/SCF Heating Value

Natural gas composition - weight basis
    75.38 % Carbon     23.40 % Hydrogen            0.00 % Oxygen
     0.00 % Sulfur      0.00 % Carbon Monoxide     1.22 % Inert gases (N2, CO2)
      23197 Btu/lb heating value

Boiler Operating Parameters -- Natural Gas
   Combustion air temp:  70 deg F     30 % relative humidity
   Flue gas temp: 350 deg F         3.00 % oxygen (dry basis)
   40.02 % combustibles
   10.27 % CO2                     86.71 % N2
   0.00481 lb/lb dry air           0.00772 mole/mole dry air
    14.94 % excess air             0.020 % combustibles
```

```
******************************************************************************
**   Central Heating Plant Economics Evaluation Program             Page 2    **
**   File: DDREA2        Type: New plant (NP)                      11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                          **
**   Tech: Gas / Oil Fired Boiler                                             **
******************************************************************************

Boiler Performance -- Natural Gas
   Sensible dry gas loss:       5.360 %    Loss H2O vapor in air:      0.044 %
   Fuel H2O heat loss:          0.000 %    H2 comb H2O heat loss:     10.718 %
   Radiation heat loss:         2.166 %    Unaccounted for loss:       1.000 %
   Combustible gas heat loss:   0.064 %
   Boiler efficiency:          80.647 %

************************* Boiler Performance @ PMCR *************************
Blowdown   :   5 %

Temperature out of stack :   350 deg F
Steam pressure           :  150 psig
Steam temperature        :  367 deg F       enthalpy  : 1195.6 Btu/lb
Condensate return temp   :  150 deg F       enthalpy  :  118.0 Btu/lb
Makeup water temperature :   50 deg F       enthalpy  :   18.0 Btu/lb
Inlet water temperature  :  120 deg F       enthalpy  :   88.1 Btu/lb

********************* Area and Water Requirements @ PMCR *********************

Building size :  6500 sq ft          Condensate Return     :    75 %
Plant area    :  1.04 acres          Boiler house leakage :     2 %
Plant height  :    40 ft             Water requirements    :   100 gpm (est)
Stack height  :    60 ft             Railway track length :   125 ft
Sewer dischrg :    25 gpm (est)
```

```
*****************************************************************************
**   Coal Fired Boiler Evaluation Program                          Page 3    **
**   File: DDREA2        Type: New plant (NP)                    11/09/94    **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                         **
**   Tech: Gas / Oil Fired Boiler                                            **
*****************************************************************************

*********************** General Site Considerations ************************

Development and Construction

     Total:      0/     0        0%

=============================================================================

Fuel Supply and Site Access

Gas purchase contracts:
  Score:    0

Oil supply contracts:
  Score:    0

     Total:      0/     0        0%

=============================================================================

Ecology

     Total:      0/     0        0%

=============================================================================

Social Considerations

     Total:      0/     0        0%

=============================================================================

Facility Services

Condition of system is good
  Score:    5
```

```
*****************************************************************************
**   Central Heating Plant Economics Evaluation Program          Page 4    **
**   File: DDREA2        Type: New plant (NP)                   11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                       **
**   Tech: Gas / Oil Fired Boiler                                          **
*****************************************************************************

Steam distribution system routing is medium
It may be difficult to incorporate the existing distribution system
into the new plant.  Additional costs may be required heavily modify
the existing distribution system.  These costs are not considered in
the new plant detailed evaluation section of this program.
  Score:   2

City water available: Yes
  Score:   5

New electrical substation required: Maybe
Additional effort and expense may be required to construct
a new substation.
  Score:   2

     Total:   125/  170      73%

=============================================================================

Waste Handling and Emissions

Local sewer system available: Yes
  Score:   5

     Total:    50/   50     100%

=============================================================================

Military

     Total:     0/    0       0%

=============================================================================
```

```
*****************************************************************************
**   Central Heating Plant Economics Evaluation Program             Page 5   **
**   File: DDREA2        Type: New plant (NP)                      11/09/94  **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                         **
**   Tech: Gas / Oil Fired Boiler                                            **
*****************************************************************************
```

General Questions Summary

	Total	Max	Rating
Development and Construction	0	0	0
Fuel Supply and Site Access	0	0	0
Ecology	0	0	0
Social Considerations	0	0	0
Facility Services	125	170	73
Waste Handling and Emissions	50	50	100
Military	0	0	0

Boiler technology rating: 10

Feasibility score: 10/10 = 100%

Central Heating Plant Economics Evaluation Program -- Cost Analysis Page 1
File: DDREA2 Type: New plant (NP) 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

****
Base and Plant Information
****

State: PA - Pennsylvania Base DOE Region: 1
PMCR: 86,000 lb/hr steam Number of boilers: 3

Height of the plant: 40 ft
Building area: 6500 sq ft
Plant area: 1.04 acres

****
Facility Parameters
****

Capital Equipment Escalation Factor: 1.102 (5032.16/1994)
Non-Labor Operation & Maintenance Escalation Factor: 1.092 (935.60/1994)
Operation & Maintenance Labor Escalation Factor: 1.119 (4626.82/1994)
Construction Labor Escalation Factor: 1.024 (271.10/1994)

Annual electricity usage: 751,784 kW-hr

1994 cost for distillate: 0.695 $/gallon
1994 cost for residual: 0.610 $/gallon
1994 cost for natural gas: 4.320 $/million Btu
1994 cost for electricity: 0.058 $/kW-hr

Annual Facility Output: 253,680 thousand lb steam
Annual Natural Gas Usage: 308 10^6 SCF
Heating plant efficiency: 80.6% natural gas
Year of Study: 1994
Years of Operation: 1998 - 2022

****
Facility Capital Costs
****

Equipment		Cost	Equipment		Cost
Boiler:	$	995,926	Stack:	$	34,709
Building/service:	$	990,945	Water trtmnt:	$	188,681
Feedwtr pmps:	$	16,786	Cond xfr pmps:	$	13,718
Cond strg tnk:	$	5,511	Oil (long) storage:	$	177,747
Oil day strg pmp:	$	4,627	Oil heaters:	$	4,848
Oil day strg tanks:	$	15,036	Oil unload pumps:	$	14,544
Oil xfr pmps:	$	4,462	Fire protection:	$	44,075
Cont bldn tnk:	$	787	Intr bldn tnk:	$	787
Compressor:	$	27,196	Car puller:	$	22,037
Rail:	$	11,707	Site preparation:	$	2,864
Site improvements:	$	157,569	Mobile equipment:	$	42,973
Elec substation:	$	58,700	Electrical:	$	120,855
Piping:	$	684,845	Instrumentation:	$	253,220
Direct costs:	$	1,373,212			

****

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 2
File: DDREA2        Type: New plant (NP)                                11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Facility Capital Costs, cont
******************************************************************************

Plant installed cost:  $      5,696,335

******************************************************************************
   Facility Annual O & M and Energy Costs
******************************************************************************

Operating staff: 10
Annual Labor Costs: $ 514,498
Annual Year Non-Labor O & M Costs : $     591,472
1998 Natural gas costs  : $   1,651,628
1998 Auxiliary Energy Costs      : $      44,664

******************************************************************************
   Periodic Major Maintenance Cost Summary
******************************************************************************

Time Interval          Cost          Time Interval          Cost
-----------------------------        -----------------------------
3 years           $    30,000        5 years           $     6,122
10 years          $    59,691        15 years          $    66,471
18 years          $     5,488        20 years          $    12,862

******************************************************************************
   Facility Life Cycle Cost Summary
******************************************************************************

Analysis using natural gas as primary fuel
+ PV 'Adjusted' Investment Costs                        = $    5,064,021
+ PV Energy + Transportation Costs                      = $   32,558,311
+ PV Annually Recurring O&M Costs                       = $    8,200,308
+ PV Non-Annually Recurring Repair & Replacement        = $      246,468
+ PV Disposal Cost of Existing System                   = $            0
+ PV Disposal Cost of New/Retrofit Facility             = $            0
                                                        -----------------
Total Life Cycle Cost (1994)                            = $   46,069,109

Levelized Cost of Service (1998 start)             = 11.374 $/MMBtu
Levelized Cost of Service (1998 start)             = 13.599 $/1000 lb steam
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 1
File: DDREA2        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Base Information
******************************************************************************

State: PA - Pennsylvania            Base DOE Region: 1
PMCR:  86,000 lb/hr steam       Number of boilers: 3

Steam Properties:  150 psi    (1195.6 Btu/lb)
Inlet water temp: 120 deg F       enthalpy:    88.1 Btu/lb

******************************************************************************
   Boiler Design Parameters
******************************************************************************

A mixed bed for condensate polishing IS NOT NEEDED
A dealkalizer unit IS INCLUDED
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 2
File: DDREA2        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Plant Design Parameters --- Space Requirements
*******************************************************************************

Height of the plant: 40 ft
Building area: 6500 sq ft
Plant area: 1.04 acres

*******************************************************************************
   Plant Design Parameters --- Water & Water Treatment Specifications
*******************************************************************************

Number of deaerators: 1
Number of resin vessels / train: 1
Number of mixed beds / train: 0
Boiler 1: 1 motor-driven feedwater pump -- 56 gpm
Boiler 2: 1 motor-driven feedwater pump -- 56 gpm
Boiler 3: 1 motor-driven feedwater pump -- 56 gpm
Number of condensate transfer pumps: 3
Condensate transfer pump size: 682 gpm

Condensate storage tank size: 2760 gallons
Number of long term oil storage tanks: 1
Capacity of one long term oil storage tank: 502000 gal
Number of oil (day storage) pumps: 3
Short term storage tank size: 2,784 gallons

Length of rail track: 125 ft
Annual personnel water use: 89,162 gallons
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 3
File: DDREA2          Type: New plant (NP)                              11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Facility Capital Costs
******************************************************************************

Boiler capital costs: $ 995,926
  Boiler #1 ( 29 k-lb stm/hr) cost: $ 331,975
  Boiler #2 ( 29 k-lb stm/hr) cost: $ 331,975
  Boiler #3 ( 29 k-lb stm/hr) cost: $ 331,975

Stack capital costs: $ 34,709

Building and service capital costs: $ 990,945
  Boiler house capital costs: $ 895,280
  Miscellaneous building costs: $ 95,664

Boiler Water Treatment System Capital Costs: $ 188,681
  Cost of zeolite softeners: $ 15,514
  Cost of dealkalizers: $ 101,706
  Cost of chemical injection skid: $ 22,037
  Cost of water lab: $ 22,037
  Cost of 1 deaerator: $ 27,385

Cost of boiler feedwater pumps: $ 16,786
Cost of condensate transfer pumps: $ 13,718

Cost of condensate storage tank: $ 5,511
Cost of long term oil storage: $ 177,747
  Cost of long term storage tanks: $ 142,942
  Cost of long term storage-other: $ 34,805

Cost of oil (day storage) pumps: $ 4,627
Cost of oil (day storage) heaters: $ 4,848
Cost of short term storage tanks: $ 15,036

Cost of oil unloading pumps: $ 14,544
Cost of [3] oil transfer pumps: $ 4,462
Cost of fire protection equipment: $ 44,075
Cost of 1 continuous blowdown tank: $ 787
Cost of 1 intermittent blowdown tank: $ 787
Compressor cost (2 - 30 Hp - 150 psig): $ 27,196

Cost of car puller and accessories: $ 22,037
Cost of rail tracks: $ 11,707

Site preparation cost: $ 2,864
Site improvement cost: $ 157,569

Total cost of mobile equipment: $ 42,973
  Cost of fork lift: $ 22,037
  Cost of pickup truck: $ 15,426
  Cost of power sweeper: $ 5,509

Cost of electric substation: $ 58,700
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 4
File: DDREA2        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Facility Capital Costs, cont
******************************************************************************

Electrical costs: $ 120,855

Piping costs: $ 684,845

Instrumentation costs: $ 253,220

Spare parts cost: $ 23,480

Initial consumables: $ 8,218

Tools cost: $ 22,037
```

```
Central Heating Plant Economics Evaluation Program --- Cost Analysis      Page 5
File: DDREA2         Type: New plant (NP)                                  11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Direct Costs
******************************************************************************

Direct costs: $ 1,373,212
  Development permit cost: $ 58,700
  Project contingency costs: $ 416,193
  Construction management costs: $ 194,223
  Engineering and design costs: $ 332,954
  Owner management costs: $ 166,477
  Startup cost: $ 204,663

******************************************************************************
   Installed Capital Equipment Cost Summary
******************************************************************************

Total Capital Costs: $ 3,070,814
Total Direct labor cost: $ 701,011
Total Freight cost: $ 59,067
Total Bulk material cost: $ 492,229
Total Direct costs: $ 1,373,212

Plant installed cost: $ 5,696,335
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 6
File: DDREA2        Type: New plant (NP)                                11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Facility Operating Labor Requirements
*******************************************************************************

Operation personnel requirements
     plant manager: 1
     plant engineer: 0
     plant technician: 0
     plant clerk: 0
     plant secretary: 0
     plant janitor: 0
     operations operator: 4
     operations assistant operator: 1
     fuel storage operator equipment: 0
     maintenance a mechanic: 1
     maintenance a electrician: 1

Operating staff: 10

Annual Labor Costs: $ 514,498
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 7
File: DDREA2        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*****************************************************************************
   Yearly O & M Costs Summary
*****************************************************************************

Annual boiler maintenance costs: $ 6,971
Annual insurance cost: $ 98,445
Maximum electrical consumption @ PMCR: 244 kW
  Annual electricity usage: 751,784 kW-hr
Annual O & M (materials/supplies) costs: $ 36,977
  Annual condensate make-up water cost: $ 22,793
  Annual blowdown make-up water cost: $ 4,558
  Annual facility washdown water cost: $ 2,340
  Annual personnel water cost: $ 267
  Annual zeolite softener water cost: $ 3,859
  Annual chemicals cost: $ 715
  Annual sanitary sewer cost: $ 2,443
Annual miscellaneous maintenance costs: $ 7,985
Study year water cost: $3.00/1000 gallon
1994 cost for distillate:  0.695 $/gallon
1994 cost for residual:  0.610 $/gallon
1994 cost for natural gas:  4.320 $/million Btu
1994 cost for electricity:  0.058 $/kW-hr
  Annual consumables cost: $ 1,643
  Annual spare parts cost: $ 3,522
  Annual mobile equipment maintenance: $ 3,437
1998 Natural gas costs  : $   1,651,628
1998 Auxiliary Energy Costs      : $       44,664
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 8
File: DDREA2        Type: New plant (NP)                                11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Periodic Maintenance Costs Summary
*******************************************************************************

Major boiler maintenance costs (every 15 years): $ 59,755
Major stack maintenance costs (every 10 years): $ 6,941
Major water treatment system maintenance costs (every 10 years): $ 52,749
Major deaerator maintenance costs (every 20 years): $ 6,846
Motor-driven feedwater pumps maint costs (every 15 years): $ 6,714
Centrifugal pump maint costs (every 18 years): $ 5,487
Sump pump maintenance costs (every 20 years): $ 6,016
Oil pump maintenance costs (every 5 years): $ 6,122
Periodic EPA permit testing/renewal costs (every 3 years): $ 30,000
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 9
File: DDREA2        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Economic Data Summary
*******************************************************************************

Capital Equipment Escalation Factor:  1.102
     based on Engineering News Record, Construction Cost Index: 5032.16

Non-Labor Operation & Maintenance Escalation Factor:  1.092
     based on Chemical Engineering, M & S Index, Steam Power Comp:  935.60

Operation & Maintenance Labor Escalation Factor:  1.119
     based on Engineering News Record, Skilled Labor Index: 4626.82

Construction Labor Escalation Factor:  1.024
     based on Chemical Engineering, Construction Labor Index:  271.10

Annual Facility Output: 253,680 thousand lb steam
Steam enthalpy:         1195.6 Btu/lb
Inlet enthalpy:           88.0 Btu/lb
Annual Natural Gas Usage: 308 10^6 SCF
Heating plant efficiency: 80.6% natural gas
Discount Rate: 4 %
Year of Study: 1994
Years of Operation: 1998 - 2022
10% Investment Cost Exclusion IS NOT applied
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis     Page 10
File: DDREA2        Type: New plant (NP)                               11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Cash Flow Summary
******************************************************************************

Analysis using natural gas as primary fuel
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
1997 adjusted investment:   5,696,335    existing plant salvage:           0
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

Year	Boiler Fuel	Auxiliary Energy	Non-Energy O&M	Repair and Replacement
1998	1,651,628	44,664	575,036	0
1999	1,724,963	45,167	591,472	0
2000	1,794,802	46,005	591,472	30,000
2001	1,868,123	46,787	591,472	0
2002	1,944,942	47,011	591,472	6,122
2003	2,014,780	47,346	591,472	30,000
2004	2,081,118	47,793	591,472	0
2005	2,150,956	48,407	591,472	0
2006	2,199,848	48,798	591,472	30,000
2007	2,259,204	49,273	591,472	65,813
2008	2,318,560	49,301	591,472	0
2009	2,409,359	49,497	591,472	30,000
2010	2,496,646	50,363	591,472	0
2011	2,541,503	50,670	591,472	0
2012	2,586,345	50,981	591,472	102,593
2013	2,631,203	51,295	591,472	0
2014	2,676,046	51,614	591,472	0
2015	2,720,902	51,935	591,472	35,488
2016	2,765,746	52,260	591,472	0
2017	2,810,603	52,589	591,472	78,675
2018	2,847,973	52,899	591,472	30,000
2019	2,885,356	53,212	591,472	0
2020	2,922,724	53,530	591,472	0
2021	2,960,094	53,852	591,472	30,000
2022	2,997,477	54,177	591,472	6,122

```
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
2023 new plant salvage:             0
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis     Page 11
File: DDREA2        Type: New plant (NP)                                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*****************************************************************************
   Life Cycle Cost Summary
*****************************************************************************

Analysis using natural gas as primary fuel
+ PV 'Adjusted' Investment Costs                         = $   5,064,021
+ PV Energy + Transportation Costs                       = $  32,558,311
+ PV Annually Recurring O&M Costs                        = $   8,200,308
+ PV Non-Annually Recurring Repair & Replacement         = $     246,468
+ PV Disposal Cost of Existing System                    = $           0
+ PV Disposal Cost of New/Retrofit Facility              = $           0
                                                          -----------------

Total Life Cycle Cost (1994)                             = $  46,069,109

Levelized Cost of Service (1998 start)              = 11.374 $/MMBtu
Levelized Cost of Service (1998 start)              = 13.599 $/1000 lb steam
```

```
****************************************************************************
**   Central Heating Plant Economics Evaluation Program          Page 1    **
**   File: DDRECOG1     Type: Cogeneration new plant (CG)        11/09/94  **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                       **
**   Tech: Gas / Oil Fired Boiler                                          **
****************************************************************************

State     : PA - Pennsylvania
Location :  40d 13m -  76d 50m
County    :
Emission regulation region
#  2 - Erie, Harrisburg, York, Lancaster, Scranton, Wilkes-Barre

Annual heating degree days:  5335

*************************** Boiler Characteristics ***************************

Type of heating system : Steam

Average Monthly Steam Flows (million Btu/hr)

                 Jan      Feb      Mar      Apr      May      Jun
                  67       67       56       30
                 Jul      Aug      Sep      Oct      Nov      Dec
                                             16       49       65

Calculated PMCR:  75 thousand lb/hr steam       *** October - March basis

Average Monthly Electrical Loads (kW)

                 Jan      Feb      Mar      Apr      May      Jun
                5225     5225     5229     5288     5483     6010
                 Jul      Aug      Sep      Oct      Nov      Dec
                6528     6336     5711     5299     5232     5225

Peak Monthly Electrical Loads (kW)

                 Jan      Feb      Mar      Apr      May      Jun
                7824     7824     7832     7959     8387     9534
                 Jul      Aug      Sep      Oct      Nov      Dec
               10665    10245     8883     7982     7837     7824

Maximum peak monthly electrical load: 10665 kW

Cogeneration efficiency: 30%
Steam required for peak: 93,994 lb/hr
Plant cannot meet steam requirements for peak

Boiler technology: Gas / Oil Fired Boiler

Boiler sizes (thousand lb steam/hr) :
         1:    0     2:    0     3:    0
```

```
*****************************************************************************
**   Central Heating Plant Economics Evaluation Program          Page 2    **
**   File: DDRECOG1     Type: Cogeneration new plant (CG)        11/09/94  **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                       **
**   Tech: Gas / Oil Fired Boiler                                          **
*****************************************************************************

Natural gas composition - volume basis
    83.40 % Methane         0.00 % Ethylene      15.80 % Ethane
     0.00 % Propane         0.00 % Butane         0.00 % Hydrogen
     0.80 % Nitrogen        0.00 % Oxygen         0.00 % Hydrogen Sulfide (H2S)
     0.00 % Carbon Monoxide (CO)                  0.00 % Carbon Dioxide (CO2)
     1129 Btu/SCF Heating Value

Natural gas composition - weight basis
    75.38 % Carbon     23.40 % Hydrogen             0.00 % Oxygen
     0.00 % Sulfur      0.00 % Carbon Monoxide      1.22 % Inert gases (N2, CO2)
      23197 Btu/lb heating value

Boiler Operating Parameters -- Natural Gas
   Combustion air temp:  70 deg F     30 % relative humidity
   Flue gas temp: 350 deg F         3.00 % oxygen (dry basis)
   40.02 % combustibles
   10.27 % CO2                     86.71 % N2
   0.00481 lb/lb dry air           0.00772 mole/mole dry air
    14.94 % excess air             0.020 % combustibles

Boiler Performance -- Natural Gas
   Sensible dry gas loss:        5.360 %    Loss H2O vapor in air:      0.044 %
   Fuel H2O heat loss:           0.000 %    H2 comb H2O heat loss:     10.718 %
   Radiation heat loss:          2.302 %    Unaccounted for loss:       1.000 %
   Combustible gas heat loss:    0.064 %
   Boiler efficiency:           80.512 %

Fuel Oil #6 composition - weight basis
    88.73 % Carbon      9.33 % Hydrogen             0.70 % Oxygen
     0.30 % Nitrogen    0.70 % Sulfur               0.04 % Ash
     0.20 % Moisture
      18126 Btu/lb heating value
   0.972 Specific gravity

Boiler Operating Parameters -- Fuel Oil #6
   Combustion air temp:  70 deg F     30 % relative humidity
   Flue gas temp: 350 deg F         2.50 % oxygen (dry basis)
   50.02 % combustibles
   14.70 % CO2                     82.78 % N2
   0.00481 lb/lb dry air           0.00772 mole/mole dry air
    12.65 % excess air             0.020 % combustibles

Boiler Performance -- Fuel Oil #6
   Sensible dry gas loss:        5.749 %    Loss H2O vapor in air:      0.048 %
   Fuel H2O heat loss:           0.013 %    H2 comb H2O heat loss:      5.469 %
   Radiation heat loss:          2.302 %    Unaccounted for loss:       1.000 %
   Combustible gas heat loss:    0.067 %
   Boiler efficiency:           85.352 %
```

```
*****************************************************************************
**   Coal Fired Boiler Evaluation Program                       Page 3    **
**   File: DDRECOG1    Type: Cogeneration new plant (CG)        11/09/94  **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                      **
**   Tech: Gas / Oil Fired Boiler                                         **
*****************************************************************************

************************* Boiler Performance @ PMCR *************************
Blowdown    :    5 %

Temperature out of stack :   350 deg F
Steam pressure           :  600 psig
Steam temperature        :  750 deg F        enthalpy  : 1378.9 Btu/lb
Condensate return temp   :  150 deg F        enthalpy  :  118.0 Btu/lb
Makeup water temperature :   50 deg F        enthalpy  :   18.0 Btu/lb
Inlet water temperature  :  120 deg F        enthalpy  :   88.1 Btu/lb

********************* Area and Water Requirements @ PMCR *********************

Building size :  9100 sq ft          Condensate Return     :    75 %
Plant area    :  1.12 acres          Boiler house leakage  :     2 %
Plant height  :    40 ft             Water requirements    :   100 gpm (est)
Stack height  :    60 ft             Railway track length  :   125 ft
Sewer dischrg :    25 gpm (est)
```

```
********************************************************************************
**   Coal Fired Boiler Evaluation Program                         Page 4     **
**   File: DDRECOG1     Type: Cogeneration new plant (CG)         11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                          **
**   Tech: Gas / Oil Fired Boiler                                             **
********************************************************************************

************************ General Site Considerations *************************

Development and Construction

     Total:      0/     0        0%

================================================================================


Fuel Supply and Site Access

Gas purchase contracts:
  Score:    0

Oil supply contracts:
  Score:    0

     Total:      0/     0        0%

================================================================================


Ecology

     Total:      0/     0        0%

================================================================================


Social Considerations

     Total:      0/     0        0%

================================================================================


Facility Services

Condition of system is good
  Score:    5
```

```
******************************************************************************
**   Central Heating Plant Economics Evaluation Program          Page 5     **
**   File: DDRECOG1      Type: Cogeneration new plant (CG)       11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                        **
**   Tech: Gas / Oil Fired Boiler                                           **
******************************************************************************

Steam distribution system routing is medium
It may be difficult to incorporate the existing distribution system
into the new plant.  Additional costs may be required heavily modify
the existing distribution system.  These costs are not considered in
the new plant detailed evaluation section of this program.
  Score:    2

City water available: Yes
  Score:    5

     Total:    115/  145      79%

==============================================================================

Waste Handling and Emissions

Local sewer system available: Yes
  Score:    5

     Total:     50/   50     100%

==============================================================================

Military

     Total:      0/    0       0%

==============================================================================

Cogeneration

Plant will operated for over 6000 hours per year
The facility will be operating enough to justify building a cogeneration
plant.
  Score:    5

The existing electricity distribution system MAY BE
     compatible with a cogeneration system
Cogeneration may not be feasible because of the additional electrical
distribution costs that will be necessary in rewiring the power lines.
  Score:    2

It IS NOT likely that energy demand will be curtailed
  Score:    5
```

```
******************************************************************************
**   Central Heating Plant Economics Evaluation Program             Page 6   **
**   File: DDRECOG1     Type: Cogeneration new plant (CG)         11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                         **
**   Tech: Gas / Oil Fired Boiler                                            **
******************************************************************************

The utility MAY/MAY NOT maintain and repair interconnection facilities
Maintaining the substation facilities may be too difficult for
the base.  Further evaluation of the substation maintenance should
be performed prior to proceeding with a detailed evaluation.
  Score:   2

The utility MAY be cooperative in setting up the
     electrical interconnections and stand by power costs
Additional costs may be required to set up the electrical interconnections
and stand by power costs.  This should be further evaluated before
proceeding to a detailed evaluation.
  Score:   2

The electric utility DOES use coal as their primary fuel
Cogeneration may not be cost effective due to the local
availability of relativaly low cost electricity generated by coal.
  Score:   1

The facility's average electrical power / steam ratio is above 75 kWh/MBtu
Cogeneration may not be cost effective because a significant portion
of the base's electric requirements must still be purchased from
the local utility.  A more detailed analysis of the electrical and
thermal load curves should be performed prior to a detailed evavuation.
  Score:   5

Cost of electricity:   5.80 cents/kWh        Cost of coal:    3.90 $/Mbtu
The high cost of fuel may make cogeneration prohibitive.
The facility's electric load is below 25 MW
Due to small facility electric load mearurements it may not be
cost effective to cogenerate.
  Score:   1

The facility's load factor is above 40%
The load factor is sufficient to warrant cogeneration.
  Score:   5

The facility's annual electrical power / steam ratio is above 75 kWh/MBtu
Cogeneration may not be cost effective because a significant portion
of the base's electric requirements must still be purchased from
the local utility.  A more detailed analysis of the electrical and
thermal load curves should be performed prior to a detailed evavuation.
  Score:   5

PMCR is below 200 MMBtu output; facility is probably not suitable for cogenerat

     Total:   340/  550      61%

==============================================================================
```

```
**********************************************************************************
**   Central Heating Plant Economics Evaluation Program              Page 7     **
**   File: DDRECOG1      Type: Cogeneration new plant (CG)           11/09/94   **
**   Desc: NEW CUMBERLAND ARMY DEPOT                                            **
**   Tech: Gas / Oil Fired Boiler                                               **
**********************************************************************************
```

General Questions Summary

	Total	Max	Rating
Development and Construction	0	0	0
Fuel Supply and Site Access	0	0	0
Ecology	0	0	0
Social Considerations	0	0	0
Facility Services	115	145	79
Waste Handling and Emissions	50	50	100
Military	0	0	0
Cogeneration	340	550	61

Boiler technology rating: 10

Feasibility score: 10/10 = 100%

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 1
File: DDRECOG1     Type: Cogeneration new plant (CG)                   11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Base and Plant Information
*******************************************************************************

State: PA - Pennsylvania           Base DOE Region: 1
PMCR:  75,000 lb/hr steam        Number of boilers: 3

Height of the plant: 40 ft
Building area: 9100 sq ft
Plant area: 1.12 acres

*******************************************************************************
   Facility Parameters
*******************************************************************************

Capital Equipment Escalation Factor:  1.102 (5032.16/1994)
Non-Labor Operation & Maintenance Escalation Factor:  1.092 ( 935.60/1994)
Operation & Maintenance Labor Escalation Factor:  1.119 (4626.82/1994)
Construction Labor Escalation Factor:  1.024 ( 271.10/1994)

Annual electricity usage: 1,122,417 kW-hr

1994 cost for distillate:  0.695 $/gallon
1994 cost for residual:  0.610 $/gallon
1994 cost for natural gas:  4.320 $/million Btu
1994 cost for electricity:  0.058 $/kW-hr

Annual Facility Output: 253,680 thousand lb steam
                        474,792 thousand lb steam (incl cogen)
Annual Natural Gas Usage: 674 10^6 SCF
Heating plant efficiency: 80.5% natural gas
Year of Study: 1994
Years of Operation: 1998 - 2022
Annual #6 Fuel Oil Usage: 4,883 10^3 gal
Heating plant efficiency: 85.4% #6 fuel oil

*******************************************************************************
   Facility Capital Costs
*******************************************************************************
```

Equipment		Cost	Equipment		Cost
Boiler:	$	743,771	Stack:	$	34,709
Building/service:	$	1,354,415	Cogen Equipment:	$	3,370,981
Water trtmnt:	$	490,736	Feedwtr pmps:	$	0
Cond xfr pmps:	$	12,306	Cond strg tnk:	$	5,283
Oil (long) storage:	$	180,596	Oil day strg pmp:	$	5,289
Oil heaters:	$	5,068	Oil day strg tanks:	$	15,166
Oil unload pumps:	$	14,544	Oil xfr pmps:	$	4,627
Fire protection:	$	44,075	Cont bldn tnk:	$	757
Intr bldn tnk:	$	757	Compressor:	$	27,196
Car puller:	$	22,037	Rail:	$	11,707
Site preparation:	$	3,085	Site improvements:	$	151,509

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 2
File: DDRECOG1      Type: Cogeneration new plant (CG)                  11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Facility Capital Costs, cont
******************************************************************************

Mobile equipment:   $         42,973    Elec substation:     $         90,654
Electrical:         $        106,103    Piping:              $        601,254
Instrumentation:    $        222,312    Direct costs:        $      2,731,945
*****************************************************************
Plant installed cost:   $      12,615,383

******************************************************************************
   Facility Annual O & M and Energy Costs
******************************************************************************

Operating staff: 11
Annual Labor Costs: $ 544,914
Annual Year Non-Labor O & M Costs : $     919,753
1998 Natural gas costs   : $   3,608,875
1998 Auxiliary Energy Costs      : $      66,685
1998 #6 fuel oil costs   : $   3,646,989

******************************************************************************
   Periodic Major Maintenance Cost Summary
******************************************************************************

Time Interval          Cost            Time Interval          Cost
----------------------------           ----------------------------
3 years            $    30,000         5 years            $   308,781
10 years           $   180,741         15 years           $    80,866
18 years           $     4,922         20 years           $    12,862
25 years           $     6,102

******************************************************************************
   Facility Life Cycle Cost Summary
******************************************************************************

Analysis using natural gas as primary fuel
+ PV 'Adjusted' Investment Costs                       = $  11,215,030
+ PV Energy + Transportation Costs                     = $  70,668,316
+ PV Annually Recurring O&M Costs                      = $  12,755,592
+ PV Non-Annually Recurring Repair & Replacement       = $   1,153,219
- PV Cogeneration Electricity Credit                   = $  43,829,719
+ PV Disposal Cost of Existing System                  = $           0
+ PV Disposal Cost of New/Retrofit Facility            = $           0
                                                       -----------------
Total Life Cycle Cost (1994)                           = $  51,962,439

Levelized Cost of Service (1998 start)            = 11.124 $/MMBtu
Levelized Cost of Service (1998 start)            = 15.339 $/1000 lb steam
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 3
File: DDRECOG1     Type: Cogeneration new plant (CG)                     11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Facility Life Cycle Cost Summary
*******************************************************************************

Analysis using #6 fuel oil as primary fuel
+ PV 'Adjusted' Investment Costs                         = $  11,215,030
+ PV Energy + Transportation Costs                       = $  68,277,894
+ PV Annually Recurring O&M Costs                        = $  12,755,592
+ PV Non-Annually Recurring Repair & Replacement         = $   1,153,219
- PV Cogeneration Electricity Credit                     = $  43,829,719
+ PV Disposal Cost of Existing System                    = $           0
+ PV Disposal Cost of New/Retrofit Facility              = $           0
                                                         ------------------
Total Life Cycle Cost (1994)                             = $  49,572,017

Levelized Cost of Service (1998 start)              = 10.612 $/MMBtu
Levelized Cost of Service (1998 start)              = 14.633 $/1000 lb steam
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 1
File: DDRECOG1     Type: Cogeneration new plant (CG)                  11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Base Information
******************************************************************************

State: PA - Pennsylvania           Base DOE Region: 1
PMCR:  75,000 lb/hr steam       Number of boilers: 3

Steam Properties:  600 psi   (1378.9 Btu/lb)
Inlet water temp: 120 deg F      enthalpy:   88.1 Btu/lb


******************************************************************************
   Boiler Design Parameters
******************************************************************************

A mixed bed for condensate polishing IS NOT NEEDED
A dealkalizer unit IS INCLUDED

******************************************************************************
   Cogeneration Subsystem Design Parameters
******************************************************************************

Average Steam Loads (1000 lb/hr)
                Jan      Feb      Mar      Apr      May      Jun
Heat/Proc:       67*      67*      56*      30        0        0
Cogen Sys:       47       47       47       47*      49*      51*
                Jul      Aug      Sep      Oct      Nov      Dec
Heat/Proc:        0        0        0       16       49*      65*
Cogen Sys:       52*      51*      50*      47*      47       47
Cogeneration efficiency: 30%
Cogen system sized for  94,000 lb steam/hr
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 2
File: DDRECOG1     Type: Cogeneration new plant (CG)                   11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Plant Design Parameters --- Space Requirements
*******************************************************************************

Height of the plant: 40 ft
Building area: 9100 sq ft
Plant area: 1.12 acres

*******************************************************************************
   Plant Design Parameters --- Water & Water Treatment Specifications
*******************************************************************************

Cooling tower-condenser water circulation rate: 10,447 gpm
Number of deaerators: 1
Number of resin vessels / train: 2
Number of mixed beds / train: 0
Number of condensate transfer pumps: 3
Condensate transfer pump size: 595 gpm

Condensate storage tank size: 2400 gallons
Number of long term oil storage tanks: 1
Capacity of one long term oil storage tank: 517000 gal
Number of oil (day storage) pumps: 3
Short term storage tank size: 2,867 gallons

Length of rail track: 125 ft
Annual cooling tower makeup water use: 75,263,038 gallons
Annual personnel water use: 93,537 gallons
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 3
File: DDRECOG1      Type: Cogeneration new plant (CG)                   11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Facility Capital Costs
******************************************************************************

Boiler capital costs: $ 743,771
  Boiler #1 (  0 k-lb stm/hr) cost: $ 247,923
  Boiler #2 (  0 k-lb stm/hr) cost: $ 247,923
  Boiler #3 (  0 k-lb stm/hr) cost: $ 247,923

Stack capital costs: $ 34,709

Building and service capital costs: $ 1,354,415
  Boiler house capital costs: $ 1,253,392
  Miscellaneous building costs: $ 101,022

Cogeneration equipment capital costs: $ 3,370,981
  Cost of condenser: $ 127,157
  Cost of cooling tower: $ 362,397
  Cost of turbine generator: $ 2,881,426

Boiler Water Treatment System Capital Costs: $ 490,736
  Cost of demineralizers: $ 386,219
  Cost of chemical injection skid: $ 33,056
  Cost of water lab: $ 44,075
  Cost of 1 deaerator: $ 27,385

Cost of boiler feedwater pumps: $ 0
Cost of condensate transfer pumps: $ 12,306

Cost of condensate storage tank: $ 5,283
Cost of long term oil storage: $ 180,596
  Cost of long term storage tanks: $ 145,419
  Cost of long term storage-other: $ 35,177

Cost of oil (day storage) pumps: $ 5,289
Cost of oil (day storage) heaters: $ 5,068
Cost of short term storage tanks: $ 15,166

Cost of oil unloading pumps: $ 14,544
Cost of [3] oil transfer pumps: $ 4,627
Cost of fire protection equipment: $ 44,075
Cost of 1 continuous blowdown tank: $ 757
Cost of 1 intermittent blowdown tank: $ 757
Compressor cost (2 - 30 Hp - 150 psig): $ 27,196

Cost of car puller and accessories: $ 22,037
Cost of rail tracks: $ 11,707

Site preparation cost: $ 3,085
Site improvement cost: $ 151,509

Total cost of mobile equipment: $ 42,973
  Cost of fork lift: $ 22,037
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 4
File: DDRECOG1     Type: Cogeneration new plant (CG)                  11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Facility Capital Costs, cont
******************************************************************************

  Cost of pickup truck: $ 15,426
  Cost of power sweeper: $ 5,509

Cost of electric substation: $ 90,654
Electrical costs: $ 106,103

Piping costs: $ 601,254

Instrumentation costs: $ 222,312

Spare parts cost: $ 29,951

Initial consumables: $ 10,482

Tools cost: $ 28,648
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 5
File: DDRECOG1     Type: Cogeneration new plant (CG)                      11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Direct Costs
******************************************************************************

Direct costs: $ 2,731,945
  Development permit cost: $ 74,878
  Project contingency costs: $ 923,088
  Construction management costs: $ 430,774
  Engineering and design costs: $ 738,471
  Owner management costs: $ 369,235
  Startup cost: $ 195,497

******************************************************************************
   Installed Capital Equipment Cost Summary
******************************************************************************

Total Capital Costs: $ 6,419,211
Total Direct labor cost: $ 1,939,188
Total Freight cost: $ 163,397
Total Bulk material cost: $ 1,361,641
Total Direct costs: $ 2,731,945

Plant installed cost: $ 12,615,383
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 6
File: DDRECOG1      Type: Cogeneration new plant (CG)                  11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Facility Operating Labor Requirements
*******************************************************************************

Operation personnel requirements
     plant manager: 1
     plant engineer: 0
     plant technician: 0
     plant clerk: 0
     plant secretary: 0
     plant janitor: 0
     operations operator: 4
     operations assistant operator: 1
     maintenance a mechanic: 1
     maintenance a electrician: 1

Operating staff: 11

Annual Labor Costs: $ 544,914
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 7
File: DDRECOG1      Type: Cogeneration new plant (CG)                    11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Yearly O & M Costs Summary
******************************************************************************

Annual boiler maintenance costs: $ 5,206
Annual insurance cost: $ 272,328
Maximum electrical consumption @ PMCR: 206 kW
  Annual electricity usage: 1,122,417 kW-hr
Annual O & M (materials/supplies) costs: $ 330,039
  Annual condensate make-up water cost: $ 42,660
  Annual blowdown make-up water cost: $ 8,532
  Annual facility washdown water cost: $ 2,340
  Annual cooling tower water cost: $ 225,789
  Annual personnel water cost: $ 280
  Annual demineralizer water cost: $ 3,999
  Annual mixed bed water cost: $ 1,550
  Annual chemicals cost: $ 18,381
  Annual sanitary sewer cost: $ 26,506
Annual miscellaneous maintenance costs: $ 8,599
Study year water cost: $3.00/1000 gallon
1994 cost for distillate:  0.695 $/gallon
1994 cost for residual:  0.610 $/gallon
1994 cost for natural gas:  4.320 $/million Btu
1994 cost for electricity:  0.058 $/kW-hr
  Annual consumables cost: $ 2,096
  Annual spare parts cost: $ 4,492
  Annual mobile equipment maintenance: $ 3,437
1998 Natural gas costs  : $   3,608,875
1998 Auxiliary Energy Costs      : $      66,685
1998 #6 fuel oil costs  : $   3,646,989
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis    Page 8
File: DDRECOG1      Type: Cogeneration new plant (CG)                 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*****************************************************************************
   Periodic Maintenance Costs Summary
*****************************************************************************

Major boiler maintenance costs (every 15 years): $ 44,626
Major stack maintenance costs (every 10 years): $ 6,941
Major cooling tower maintenance costs (every 15 years): $ 36,239
Turbine generator maintenance costs (every 5 years): $ 302,549
Major water treatment system maintenance costs (every 10 years): $ 173,798
Major deaerator maintenance costs (every 20 years): $ 6,846
Motor-driven feedwater pumps maint costs (every 15 years): $ 0
Centrifugal pump maint costs (every 18 years): $ 4,922
Circulation water pump maintenance costs (every 25 years): $ 6,102
Sump pump maintenance costs (every 20 years): $ 6,016
Oil pump maintenance costs (every 5 years): $ 6,231
Periodic EPA permit testing/renewal costs (every 3 years): $ 30,000
```

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 9
File: DDRECOG1     Type: Cogeneration new plant (CG)                    11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

*****************************************************************************
   Economic Data Summary
*****************************************************************************

Capital Equipment Escalation Factor:  1.102
     based on Engineering News Record, Construction Cost Index: 5032.16

Non-Labor Operation & Maintenance Escalation Factor:  1.092
     based on Chemical Engineering, M & S Index, Steam Power Comp:  935.60

Operation & Maintenance Labor Escalation Factor:  1.119
     based on Engineering News Record, Skilled Labor Index: 4626.82

Construction Labor Escalation Factor:  1.024
     based on Chemical Engineering, Construction Labor Index:  271.10

Annual Facility Output: 253,680 thousand lb steam
                        474,792 thousand lb steam (incl cogen)
Steam enthalpy:         1378.9 Btu/lb
Inlet enthalpy:           88.0 Btu/lb
Annual Natural Gas Usage: 674 10^6 SCF
Heating plant efficiency: 80.5% natural gas
Discount Rate: 4 %
Cogeneration Electricity Credit Basis: 48,215,930 kW-hr
Year of Study: 1994
Years of Operation: 1998 - 2022
10% Investment Cost Exclusion IS NOT applied
Annual #6 Fuel Oil Usage: 4,883 10^3 gal
Heating plant efficiency: 85.4% #6 fuel oil
```

Central Heating Plant Economics Evaluation Program -- Cost Analysis Page 10
File: DDRECOG1 Type: Cogeneration new plant (CG) 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

Cash Flow Summary

Analysis using natural gas as primary fuel

1997 adjusted investment: 12,615,383 existing plant salvage: 0

Year	Boiler Fuel	Auxiliary Energy	Non-Energy O&M	Repair and Replacement	Cogen Elec Credit
1998	3,608,875	66,685	898,787	0	2,864,603
1999	3,769,117	67,435	919,753	0	2,896,847
2000	3,921,717	68,686	919,753	30,000	2,950,598
2001	4,081,927	69,854	919,753	0	3,000,758
2002	4,249,780	70,188	919,753	308,781	3,015,087
2003	4,402,377	70,688	919,753	30,000	3,036,594
2004	4,547,330	71,355	919,753	0	3,065,247
2005	4,699,929	72,272	919,753	0	3,104,641
2006	4,806,758	72,857	919,753	30,000	3,129,736
2007	4,936,454	73,565	919,753	489,522	3,160,185
2008	5,066,150	73,607	919,753	0	3,161,980
2009	5,264,550	73,899	919,753	30,000	3,174,514
2010	5,455,274	75,192	919,753	0	3,230,059
2011	5,553,289	75,651	919,753	0	3,249,772
2012	5,651,272	76,116	919,753	419,647	3,269,732
2013	5,749,287	76,585	919,753	0	3,289,883
2014	5,847,272	77,060	919,753	0	3,310,284
2015	5,945,284	77,540	919,753	34,922	3,330,907
2016	6,043,269	78,025	919,753	0	3,351,749
2017	6,141,284	78,516	919,753	502,384	3,372,841
2018	6,222,939	78,979	919,753	30,000	3,392,721
2019	6,304,621	79,446	919,753	0	3,412,819
2020	6,386,272	79,921	919,753	0	3,433,194
2021	6,467,927	80,401	919,753	30,000	3,453,817
2022	6,549,611	80,887	919,753	314,883	3,474,716

2023 new plant salvage: 0

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis      Page 11
File: DDRECOG1     Type: Cogeneration new plant (CG)                     11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Life Cycle Cost Summary
******************************************************************************

Analysis using natural gas as primary fuel
+ PV 'Adjusted' Investment Costs                          = $  11,215,030
+ PV Energy + Transportation Costs                        = $  70,668,316
+ PV Annually Recurring O&M Costs                         = $  12,755,592
+ PV Non-Annually Recurring Repair & Replacement          = $   1,153,219
- PV Cogeneration Electricity Credit                      = $  43,829,719
+ PV Disposal Cost of Existing System                     = $           0
+ PV Disposal Cost of New/Retrofit Facility               = $           0

                                                          -----------------

Total Life Cycle Cost (1994)                              = $  51,962,439

Levelized Cost of Service (1998 start)               = 11.124 $/MMBtu
Levelized Cost of Service (1998 start)               = 15.339 $/1000 lb steam
```

Central Heating Plant Economics Evaluation Program -- Cost Analysis Page 12
File: DDRECOG1 Type: Cogeneration new plant (CG) 11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

****
Cash Flow Summary
****

Analysis using #6 fuel oil as primary fuel

1997 adjusted investment: 12,615,383 existing plant salvage: 0

Year	Boiler Fuel	Auxiliary Energy	Non-Energy O&M	Repair and Replacement	Cogen Elec Credit
1998	3,646,989	66,685	898,787	0	2,864,603
1999	3,831,545	67,435	919,753	0	2,896,847
2000	4,016,072	68,686	919,753	30,000	2,950,598
2001	4,174,273	69,854	919,753	0	3,000,758
2002	4,314,871	70,188	919,753	308,781	3,015,087
2003	4,437,888	70,688	919,753	30,000	3,036,594
2004	4,534,581	71,355	919,753	0	3,065,247
2005	4,640,023	72,272	919,753	0	3,104,641
2006	4,727,915	72,857	919,753	30,000	3,129,736
2007	4,824,582	73,565	919,753	489,522	3,160,185
2008	4,903,671	73,607	919,753	0	3,161,980
2009	4,991,535	73,899	919,753	30,000	3,174,514
2010	5,079,426	75,192	919,753	0	3,230,059
2011	5,170,668	75,651	919,753	0	3,249,772
2012	5,261,935	76,116	919,753	419,647	3,269,732
2013	5,353,177	76,585	919,753	0	3,289,883
2014	5,444,417	77,060	919,753	0	3,310,284
2015	5,535,654	77,540	919,753	34,922	3,330,907
2016	5,626,921	78,025	919,753	0	3,351,749
2017	5,718,161	78,516	919,753	502,384	3,372,841
2018	5,794,207	78,979	919,753	30,000	3,392,721
2019	5,870,250	79,446	919,753	0	3,412,819
2020	5,946,293	79,921	919,753	0	3,433,194
2021	6,022,311	80,401	919,753	30,000	3,453,817
2022	6,098,355	80,887	919,753	314,883	3,474,716

2023 new plant salvage: 0

```
Central Heating Plant Economics Evaluation Program -- Cost Analysis     Page 13
File: DDRECOG1     Type: Cogeneration new plant (CG)                   11/09/94
Desc: NEW CUMBERLAND ARMY DEPOT
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Life Cycle Cost Summary
******************************************************************************

Analysis using #6 fuel oil as primary fuel
+ PV 'Adjusted' Investment Costs                          = $  11,215,030
+ PV Energy + Transportation Costs                        = $  68,277,894
+ PV Annually Recurring O&M Costs                         = $  12,755,592
+ PV Non-Annually Recurring Repair & Replacement          = $   1,153,219
- PV Cogeneration Electricity Credit                      = $  43,829,719
+ PV Disposal Cost of Existing System                     = $           0
+ PV Disposal Cost of New/Retrofit Facility               = $           0

                                                          -----------------

Total Life Cycle Cost (1994)                              = $  49,572,017

Levelized Cost of Service (1998 start)               = 10.612 $/MMBtu
Levelized Cost of Service (1998 start)               = 14.633 $/1000 lb steam
```

Appendix F: REEP Analysis

REEP COMPOSITE SUMMARY REPORT Page 1

10/27/94

TOTAL INVESTMENT	$3,948,279
TOTAL NET DISCOUNTED SAVINGS	$8,233,442
TOTAL ANNUAL SAVINGS	$624,919
COMPOSITE SIMPLE PAYBACK - YEARS	6.32

RESOURCE SAVINGS	ACTUAL CONSUMPTION	UNITS	REEP ESTIMATED SAVINGS	PERCENT SAVINGS
Demand	9,850	Kw	1,843	18.71
Electric	161,114	MBtu/Yr	24,554	15.24
Gas	0	MBtu/Yr	0	**.**
Oil	311,001	MBtu/Yr	24,011	7.72
Coal	0	MBtu/Yr	0	**.**
Total	472,115	MBtu/Yr	48,565	10.28
Water	114,594	KGal	20,387	17.79
Sewage	44,835	KGal		

FINANCIAL SAVINGS	ACTUAL COSTS	UNITS	REEP ESTIMATED SAVINGS	PERCENT SAVINGS
Demand		Dollars	$89,572	
Electric		Dollars	$301,740	
Total	$2,522,222	Dollars	$391,312	15.51
Gas		Dollars	$0	
Oil		Dollars	$97,005	
Coal		Dollars	$0	
Total	$1,299,341	Dollars	$97,005	7.47
Water	$206,200	Dollars		
Sewage	$90,495	Dollars		
Total	$296,695	Dollars	$61,211	20.63
Totals	$4,118,258	Dollars	$549,528	13.34
Societal Savings		Dollars	$441,200	

POLLUTION SAVINGS	CURRENT POLLUTION ESTIMATE	UNITS	REEP ESTIMATED REDUCTION	PERCENT REDUCTION
SOx	533.65	Tons/Yr	73.31	13.73
NOx	154.63	Tons/Yr	21.21	13.71
Particulate	22.95	Tons/Yr	3.10	13.50
CO	10.22	Tons/Yr	1.16	11.33
CO2	61,964.89	Tons/Yr	7,455.72	12.03
Hydrocarbons	1.20	Tons/Yr	0.12	9.91
Total	62,687.57	Tons/Yr	7,554.62	12.05
CFCs		Lbs/Yr	0	

ENERGY TARGET SUMMARY			CONSERVATION POTENTIAL
1985 Energy Consumption	(Mbtu)	272,681	1993 REEP Resource
1985 Building Sq. Ft.	(KSF)	5,404	Savings Potential
1985 Energy Use Intensity	(KBtu/SF)	50	48,565 (MBtu/Yr)
1993 Energy Consumption	(Mbtu)	472,115	Actual 85/93 Reduction -68.28%
1993 Building Sq. Ft.	(KSF)	5,560	Potntl 85/93 Reduction -50.97%
1993 Energy Use Intensity	(KBtu/SF)	84	

REEP INSTALLATION REPORT Page 1
10/27/94

INSTALLATION: New Cumberland

FIELD	DESCRIPTION	VALUE	UNITS
SER	Department of Defense Service	ARMY	
INS	Installation	New Cumberland	
MAC	Major Command		
POP	Population	5410.00	Persons
WATSERQ	Water Service Quantity	114594.00	Kgal
WATSERT	Water Service Total Cost	206200.00	$
WATSERU	Water Service Unit Cost	1.80	$/Kgal
WATDIS	Water Distribution	94.00	K Lin Ft
SEWSERQ	Sewage Service Quantity	44835.00	Kgal
SEWSERT	Sewage Service Total Cost	90495.00	$
SEWSERU	Sewage Service Unit Cost	2.02	$/Kgal
ELESERQ	Electricity Service Quantitiy	47220.00	MWH
ELESERT	Electric Service Total Cost	2522222.00	$
ELESERU	Electric Service Unit Cost	53.41	$/MWH
GOCSERT	Gas, Oil, and Coal Service Total Cost	1299341.00	$
BUISERQ	Building Service Quantity	5560.00	K Sq Ft
BASARE	Baseline (1985) Building Area	5404.00	KSF
BASCON	Baseline (1985) Energy Consumption	272681.00	MBtu
GHP35CAP	Gas Fired Heating Plant > 3.5 Mbtu/Hr	0.00	Mbtu
GHP35CON	Gas Fired Heating Plant > 3.5 Mbtu/Hr	0.00	Mbtu
OHP35CAP	Oil Fired Heating Plant > 3.5 Mbtu/Hr	166.00	Mbtu
OHP35CON	Oil Fired Heating Plant > 3.5 Mbtu/Hr	288411.00	Mbtu
CHP35CAP	Coal Fired Heating Plant > 3.5 Mbtu/H	0.00	Mbtu
CHP35CON	Coal Fired Heating Plant > 3.5 Mbtu/H	0.00	Mbtu
GHP7535CAP	Gas Fired Heating Plant .75 - 3.5 Mbt	0.00	Mbtu
GHP7535CON	Gas Fired Heating Plant .75 - 3.5 Mbt	0.00	Mbtu
OHP7535CAP	Oil Fired Heating Plant .75 - 3.5 Mbt	0.00	Mbtu
OHP7535CON	Oil Fired Heating Plant .75 - 3.5 Mbt	22590.00	Mbtu
CHP7535CAP	Coal Fired Heating Plant .75 - 3.5 Mb	0.00	Mbtu
CHP7535CON	Coal Fired Heating Plant .75 - 3.5 Mb	0.00	Mbtu
GHP75CAP	Gas Fired Heating Plant < .75 Mbtu/Hr	0.00	Mbtu
GHP75CON	Gas Fired Heating Plant < .75 Mbtu/Hr	0.00	Mbtu
OHP75CAP	Oil Fired Heating Plant < .75 Mbtu/Hr	21.00	Mbtu
OHP75CON	Oil Fired Heating Plant < .75 Mbtu/Hr	0.00	Mbtu
CHP75CAP	Coal Fired Heating Plant < .75 Mbtu/H	0.00	Mbtu
CHP75CON	Coal Fired Heating Plant < .75 Mbtu/H	0.00	Mbtu
ACW100CAP	A/C and Chilled Water Plant > 100 Ton	3458.00	Tons
ACW5100CAP	A/C and Chilled Water Plant 5 - 100 T	0.00	Tons
ACW5CAP	A/C and Chilled Water Plant < 5 Tons	161.00	Tons
TRAARE	Training Area	7.00	K Sq Ft
MAIPROARE	Maintenance and Production Area	222.00	K Sq Ft
RDTARE	Research, Development, and Testing Ar	12.00	K Sq Ft
STOARE	Storage Area	4234.00	K Sq Ft
HOSMEDARE	Hospital and Medical Area	7.00	K Sq Ft
ADMARE	Administrative Area	534.00	K Sq Ft
BARARE	Barracks Area	61.00	K Sq Ft
COMFACARE	Common Facilities Area	170.00	K Sq Ft
FAMHOUARE	Family Housing Area	205.00	K Sq Ft
OTHARE	Other Area	108.00	K Sq Ft
CIT	City	HARRISBURG	
STA	State	PA	
LATDEG	Degrees Latitude	40.00	Degrees
LATMIN	Minutes Latitude	26.00	Min
LONDEG	Degrees Longitude	76.00	Degrees
LONMIN	Minutes Longitude	34.00	Min
ELE	Elevation	475.00	Ft
HDD	Heating Degree Days	5609.00	F
CDD	Cooling Degree Days	945.00	F
WINDESTEM	Winter Design Temperature	8.00	F

REEP INSTALLATION REPORT Page 2
10/27/94

INSTALLATION: New Cumberland

FIELD	DESCRIPTION	VALUE	UNITS
SUMDESTEM	Summer Design Temperature	90.00	F
MCWT	Mean Coincident Wet Bulb (MCWB) Tempe	74.00	F
MDRT	Mean Daily Temperature Range	24.00	F
TOTGLORAD	Total Global Radiation	1149.80	K J/Sq M
VTDD	Radiation / Degree Days	16.45	Btu/SF/DD
SACDBH	Summer A/C Criteria Dry Bulb Hours >	627.00	Hrs
SACWBH	Summer A/C Criteria Wet Bulb Hours >	1326.00	Hrs
ACLOGTST	Air Conditioning Logic Test	1.00	
ANNHOUDRY	Annual Dry Bulb Hours	3563.00	Hrs
HOUR8084	Annual Dry Bulb Hours (80 - 84 F)	393.00	Hrs
HOUR8589	Annual Dry Bulb Hours (85 - 89 F)	216.00	Hrs
MCWB8084	Mean Coincident Wet Bulb Temperature	69.00	F
MCWB8589	Mean Coincident Wet Bulb Temperature	72.00	F
COOFAC	Cooling Factor	4.58	
HEAFAC	Heating Factor	1.75	
LIGCOOFRA	Lighting Cooling Fraction	0.41	%
LIGHEAFRA	Lighting Heating Fraction	0.24	%
SHWPIP	Steam and Hot Water Distribution Syst	0.00	K Lin Ft
GROTEM	Ground Temperature	52.17	F
FULLOAHEA	Full Load Heating Hours	2244.00	Hrs
FULLOACOO	Full Load Cooling Hours	1890.00	Hrs
FULOHEAFH	Full Load Heating Hours for Family Ho	2171.00	Hrs
HEASEADAY	Heating Season Days	217.10	Days
COOSEADAY	Cooling Season Days	41.10	Days
LOCIND	Location Indices	1.01	
ADJELECOS	Adjusted Electricity Cost	12.29	$/Mbtu
BASDEMCOS	Baseload Demand Cost	52.68	$/KW
SUMDEMCOS	Summer Demand Cost	17.56	$/KW
ADJGASCOS	Adjusted Gas Cost	3.83	$/Mbtu
ADJOILCOS	Adjusted Oil Cost	4.04	$/Mbtu
COACOS	Coal Cost	0.00	$/Mbtu
ELECOS	Electricity Cost	0.04	$/KWH
ELEKWPDEM	Peak Demand for Electricity	9850.00	KW
DISFACTAB	Discount Factor Table	1.00	
COAELEGEN	Electricity Generated by Coal	0.62	%
PETELEGEN	Electricity Generated by Petroleum	0.01	%
GASELEGEN	Electricity Generated by Gas	0.00	%
HYDELEGEN	Electricity Generated by Hydro-electr	0.01	%
NUCELEGEN	Electricity Generated by Nuclear Powe	0.36	%
OTHELEGEN	Electricity Generated by Other Means	0.00	%
CO2	Carbon Dioxide Emissions	441.05	Lbs/Mbtu
SO2	Sulfur Dioxide Emissions	5.30	Lbs/Mbtu
NOX	Nitrogen Oxide Emissions	1.53	Lbs/Mbtu
CO	Carbon Monoxide Emissions	0.06	Lbs/Mbtu
HC	Hydrocarbon Emissions	0.01	Lbs/Mbtu
PAR	Particulate Emissions	0.22	Lbs/Mbtu
PURELE	Purchased Electricity	47220.00	MWH
EXTLIG	Exterior Lighting	326.00	Lights
WINPOWCLA	Wind Power Class	3.00	
PF4FTFLUOR	Penetration for 4' Fluorescent Ltng	0.15	%
PF65CEILIN	Penetration for 6.5 Inch Addtnl Clg I	0.73	%
PF6CEILGFH	Penetration for FH 6.0 Inch Addtnl Cl	0.15	%
PFACUNITFH	Penetration for FH High SEER AC	0.30	%
PFADJUSPEL	Penetration for Ventln Motor ASD (Lar	0.15	%
PFADJUSPEM	Penetration for Ventln Motor ASD (Med	0.15	%
PFADJUSPES	Penetration for Ventln Motor ASD (Sma	0.15	%
PFBLOWINFH	Penetration for FH Rockwool Wall Insu	0.55	%
PFCHILDFRL	Penetration for Large DF Chillers	0.15	%
PFCHILDFRM	Penetration for Medium DF Chillers	0.40	%

REEP INSTALLATION REPORT Page 3
10/27/94

INSTALLATION: New Cumberland

FIELD	DESCRIPTION	VALUE	UNITS
PFCHILDFRS	Penetration for Small DF Chillers	0.40	%
PFCHILGASL	Penetration for Large Gas Chillers	0.40	%
PFCHILGASM	Penetration for Medium Gas Chillers	0.40	%
PFCHILGASS	Penetration for Small Gas Chillers	0.40	%
PFCHILHEFL	Penetration for Large High Eff Chille	0.40	%
PFCHILHEFM	Penetration for Medium High Eff Chill	0.40	%
PFCHILHEFS	Penetration for Small High Eff Chille	0.40	%
PFCOMPFLUO	Penetration for Compact Fluorescent L	0.40	%
PFCONSLEVE	Penetration for Constant Level Lighti	0.03	%
PFCOOLSTOR	Penetration for Storage Cooling Syste	0.10	%
PFDESUPERH	Penetration for FH Desuperheaters	0.30	%
PFDISHWASH	Penetration for Water Consrvng Dishws	0.00	%
PFDISTLEAK	Penetration for Water Distibtn Leak R	0.20	%
PFDUCTINSU	Penetration for FH Insulate Ducts	0.05	%
PFDUCTSEAL	Penetration for FH Duct Seals	0.28	%
PFEFFICOMP	Penetration for Efficient Computers	0.00	%
PFEFFISTRE	Penetration for Efficient Street Ligh	0.23	%
PFENERMONI	Penetration for EMCS	0.35	%
PFENTHALPY	Penetration for Enthalpy Recvry Dessc	0.02	%
PFEVAPCOOL	Penetration for Evap. Pre-Cool Air	0.02	%
PFEXITLIGH	Penetration for Exit Lighting	0.18	%
PFEXTEINSU	Penetration for Ext Insul Finish Sys	0.01	%
PFFAUCFLOW	Penetration for Faucet Aerators	0.45	%
PFFHFLAMEB	Penetration for FH Flame Ret. Burners	0.30	%
PFFHOILFUN	Penetration for FH HiEff Oil Furn	0.00	%
PFFLAMERET	Penetration for Flame Retention Burne	0.33	%
PFFLUSHVAL	Penetration for Flush Valves	0.30	%
PFGASBOILR	Penetration for Gas Nomeff Boiler	0.00	%
PFGASENGIF	Penetration for FH Gas Engine Drvn HP	0.30	%
PFGASFURNF	Penetration for FH HiEff Gas Furn	0.30	%
PFGROUPUMF	Penetration for FH Ground Source HP	0.30	%
PFHEATPUMF	Penetration for FH Heat Pumps	0.30	%
PFHEATREPA	Penetration for Undrgrnd Heat Dist Sy	0.50	%
PFHIGHREFR	Penetration for High Eff Refrig Replc	0.15	%
PFHIWATINC	Penetration for High wattage incand r	0.00	%
PFHORIWASH	Penetration for Horizntl Axis Washng	0.00	%
PFHOTWATEH	Penetration for FH Hot Water Heat Pum	0.00	%
PFINSTHOTW	Penetration for FH Tankless Water Hea	0.00	%
PFLOFLOTOI	Penetration for FH Low Flow Toilets	0.05	%
PFMANHSUMP	Penetration for Manhl Sump-Pmp I/R Pr	0.50	%
PFMICRCLIM	Penetration for Microclimate Modifica	0.06	%
PFNOMIFURF	Penetration for FH NomEff Gas Furn	0.30	%
PFOCCUSENS	Penetration for Occupancy Sensor	0.05	%
PFOILBOILR	Penetration for Oil Nomeff Boiler	0.00	%
PFPASOLRFH	Penetration for FH Passive Solar Suns	0.01	%
PFPHOTOVOL	Penetration for Photovoltaic Peaking	0.00	%
PFPROGTHER	Penetration for FH Progrmmbl Thermost	0.23	%
PFPULSCOMB	Penetration for Gas Hieff Boilers	0.15	%
PFRADIBARR	Penetration for Radiant Barriers	0.00	%
PFROOFSURF	Penetration for High Reflctnce Roof M	0.10	%
PFSHADSCRE	Penetration for Shading Devices	0.05	%
PFSHOWFLOW	Penetration for Low-flow Shower Head	0.45	%
PFSINGLOOP	Penetration for SLDC Panels	0.15	%
PFSODILAMP	Penetration for High Pressure Sodium	0.33	%
PFSOLASTRE	Penetration for Solar Street Lighting	0.02	%
PFSOLAWALL	Penetration for SolarWall for Maint B	0.02	%
PFSOLAWHBA	Penetration for Barracks Solar Water	0.10	%
PFSOLAWHFH	Penetration for FH Solar Water Htg	0.10	%
PFSTORWIND	Penetration for Storm Windows	0.30	%

REEP INSTALLATION REPORT
10/27/94

Page 4

INSTALLATION: New Cumberland

FIELD	DESCRIPTION	VALUE	UNITS
PFTRANSFOR	Penetration for Amorphs Core Transfrm	0.05	%
PFULTLOFLO	Penetration for FH Ultra Low Flow Toi	0.00	%
PFVENTHEAT	Penetration for Ventilation Heat Reco	0.10	%
PFVENTMOTL	Penetration for High Eff Motors (Larg	0.20	%
PFVENTMOTM	Penetration for High Eff Motors (Medi	0.20	%
PFVENTMOTS	Penetration for High Eff Motors (Smal	0.20	%
PFWATEBLAN	Penetration for Wtr Htr Insulation Bl	0.53	%
PFWHFANSFH	Penetration for FH Whole House Fans w	0.05	%
PFWINDENER	Penetration for Wind Energy	0.01	%
PFWINDFILM	Penetration for Window Film	0.18	%

REEP FINANCIAL SUMMARY REPORT

10/27/94

ECO Type / ECO	ECO Units	Unit	Total Investment ($)	Total Net Dis. Savings ($)	Annual Savings ($)	Simp Paybk (Yrs)	SIR	AIRR (%)	Societal Savings ($)
Electrical									
High Eff Motors (Large)	11	Motors	18323	64583	4225	4.34	3.52	10.75	4260
High Eff Motors (Medium)	13	Motors	13970	46702	3055	4.57	3.34	10.46	3111
High Eff Motors (Small)	133	Motors	60932	168204	10997	5.54	2.76	9.42	11349
Ventln Motor ASD (Large)	1	Motors	6788	9415	1082	6.27	1.39	7.48	1433
Ventln Motor ASD (Medium)	1	Motors	3677	5273	606	6.07	1.43	7.79	814
Ventln Motor ASD (Small)	0	Motors	0	0	0	0.00	0.00	0.00	0
Envelope									
6.5 Inch Addtnl Clg Insul	73035	Sq. Ft.	40896	152706	8932	4.58	3.73	11.08	6739
Ext Insul Finish Sys	0	Sq. Ft.	0	0	0	0.00	0.00	0.00	0
FH 6.0 Inch Addtnl Clg In	0	Sq. Ft.	0	0	0	0.00	0.00	0.00	0
FH Rockwool Wall Insulati	0	Sq. Ft.	0	0	0	0.00	0.00	0.00	0
High Reflctnce Roof Membr	0	Sq. Ft.	0	0	0	0.00	0.00	0.00	0
Radiant Barriers	0	Sq. Ft.	0	0	0	0.00	0.00	0.00	0
Shading Devices	0	Sq. Ft.	0	0	0	0.00	0.00	0.00	0
Storm Windows	0	Sq. Ft.	0	0	0	0.00	0.00	0.00	0
Window Film	11058	Sq. Ft.	23410	47043	5142	4.55	2.01	11.52	3773
Heating/Cooling									
Enthalpy Recvry Desscnt W	0	Wheels	0	0	0	0.00	0.00	0.00	0
Evap. Pre-Cool Air	0	Units	0	0	0	0.00	0.00	0.00	0
FH Desuperheaters	96	Desprhtrs	66135	112487	7308	9.05	1.70	6.80	8813
FH Duct Seals	74	Houses	11300	25750	1671	6.76	2.28	8.38	2057
FH Flame Ret. Burners	0	Burners	0	0	0	0.00	0.00	0.00	0
FH Gas Engine Drvn HP	0	Heat Pumps	0	0	0	0.00	0.00	0.00	0
FH Ground Source HP	0	Heat Pumps	0	0	0	0.00	0.00	0.00	0
FH Heat Pumps	0	Heat Pumps	0	0	0	0.00	0.00	0.00	0
FH HiEff Gas Furn	0	Furnaces	0	0	0	0.00	0.00	0.00	0
FH HiEff Oil Furn	137	Furnaces	131729	263338	15178	8.68	2.00	7.67	10347
FH High SEER AC	0	ACs	0	0	0	0.00	0.00	0.00	0
FH Insulate Ducts	7790	Sq. Ft.	20357	42835	2506	8.12	2.10	7.93	1897
FH Nom Eff Gas Furn	0	Furnaces	0	0	0	0.00	0.00	0.00	0
FH Progrmmbl Thermostats	105	Thermstats	10169	37307	2765	3.68	3.67	13.42	1930
FH Whole House Fans w/AC	0	Fans	0	0	0	0.00	0.00	0.00	0
Flame Retention Burners	5	Burners	4809	47457	3531	1.36	9.87	21.15	2400
Gas Hieff Boilers	0	Boilers	0	0	0	0.00	0.00	0.00	0
Gas Nomeff Boiler	0	Boilers	0	0	0	0.00	0.00	0.00	0
Oil Nomeff Boiler	7	Boilers	39592	64512	4800	8.25	1.63	7.44	3282
SLDC Panels	34	Panels	452192	1138578	68341	6.62	2.52	8.92	50966
Ventilation Heat Recovery	30	Heat Exchs	101808	267051	15304	6.65	2.62	9.13	11160
Lighting									
4' Fluorescent Ltng	15337	Fixtures	1867779	2772271	229773	8.13	1.48	6.75	179066

REEP FINANCIAL SUMMARY REPORT

10/27/94

ECO Type / ECO	ECO Units	Unit	Total Investment ($)	Total Net Dis. Savings ($)	Annual Savings ($)	Simp Paybk (Yrs)	SIR	AIRR (%)	Societal Savings ($)
Compact Fluorescent Ltng	3676	Lamps	35333	365541	30282	1.17	10.35	21.53	24228
Constant Level Lighting	0	Contrllrs	0	0	0	0.00	0.00	0.00	0
Exit Lighting	432	Fixtures	21990	269759	22579	0.97	12.27	22.92	7969
High Pressure Sodium Lght	376	Lamps	76559	113732	9384	8.16	1.49	6.80	7849
High wattage incand replc	3176	Fixtures	634600	994116	82356	7.71	1.57	7.17	65902
Occupancy Sensor	1338	Sensors	104423	165973	13594	7.68	1.59	7.27	13240
Miscellaneous									
Efficient Computers	0	Computers	0	0	0	0.00	0.00	0.00	0
High Eff Refrig Replcmnt	0	Refrgrtrs	0	0	0	0.00	0.00	0.00	0
Renewables									
Barracks Solar Water Htg	0	Barracks	0	0	0	0.00	0.00	0.00	0
FH Passive Solar Sunspace	0	Rooms	0	0	0	0.00	0.00	0.00	0
FH Solar Water Htg	0	Houses	0	0	0	0.00	0.00	0.00	0
Microclimate Modification	0	Houses	0	0	0	0.00	0.00	0.00	0
Photovoltaic Peaking Stat	0	Kw	0	0	0	0.00	0.00	0.00	0
Solar Street Lighting	0	Fixtures	0	0	0	0.00	0.00	0.00	0
SolarWall for Maint Bldgs	4308	Sq. Ft.	87717	205233	11829	7.42	2.34	8.52	8056
Wind Energy	0	Turbines	0	0	0	0.00	0.00	0.00	0
Utilities									
Amorphs Core Transfrmrs	0	KVAR	0	0	0	0.00	0.00	0.00	0
DF NG Chllrs 5-50 Tons	0	Chillers	0	0	0	0.00	0.00	0.00	0
DF NG Chllrs 50-100 Tons	0	Chillers	0	0	0	0.00	0.00	0.00	0
DF NG Chllrs >100 Tons	0	Chillers	0	0	0	0.00	0.00	0.00	0
EMCS	0	Points	0	0	0	0.00	0.00	0.00	0
GasEng Chllrs 5-50 Tons	0	Chillers	0	0	0	0.00	0.00	0.00	0
GasEng Chllrs 50-100 Tons	0	Chillers	0	0	0	0.00	0.00	0.00	0
GasEng Chllrs >100 Tons	0	Chillers	0	0	0	0.00	0.00	0.00	0
HiEff Chllrs 5-50 Tons	0	Chillers	0	0	0	0.00	0.00	0.00	0
HiEff Chllrs 50-100 Tons	0	Chillers	0	0	0	0.00	0.00	0.00	0
HiEff Chllrs >100 Tons	0	Chillers	0	0	0	0.00	0.00	0.00	0
Manhl Sump-Pmp I/R Prgrm	0	Units	0	0	0	0.00	0.00	0.00	0
Storage Cooling Systems	0	Ton-Hours	0	0	0	0.00	0.00	0.00	0
Undrgrnd Heat Dist Sys Rp	0	Repairs	0	0	0	0.00	0.00	0.00	0
Water									
FH Hot Water Heat Pump	0	Heat Pumps	0	0	0	0.00	0.00	0.00	0
FH Low Flow Toilets	0	Toilets	0	0	0	0.00	0.00	0.00	0
FH Tankless Water Heaters	0	Heaters	0	0	0	0.00	0.00	0.00	0
FH Ultra Low Flow Toilets	273	Toilets	87936	394988	26797	3.28	4.49	12.11	0
Faucet Aerators	226	Aerators	1277	22041	2566	0.50	17.26	38.27	1604
Flush Valve Retrofits	217	Valves	2087	125864	14825	0.14	60.31	56.70	0
Horizntl Axis Washng Mchn	0	Machines	0	0	0	0.00	0.00	0.00	0

REEP FINANCIAL SUMMARY REPORT

10/27/94

ECO Type ECO	ECO Units	Unit	Total Investment ($)	Total Net Dis. Savings ($)	Annual Savings ($)	Simp Paybk (Yrs)	SIR	AIRR (%)	Societal Savings ($)
Low-flow Shower Head	75	Shwr Heads	1697	63575	7395	0.23	37.46	49.41	4922
Water Consrvng Dishwshrs	0	Dishwshrs	0	0	0	0.00	0.00	0.00	0
Water Distibtn Leak Repai	14	Repairs	16668	218918	14852	1.12	13.13	18.29	0
Wtr Htr Insulation Blanke	192	Blankets	4126	28190	3244	1.27	6.83	26.03	4033
Totals			3948279	8233442	624919	6.32	2.09		441200

REEP RESOURCE SUMMARY REPORT

10/27/94

ECO Type / ECO	Demand Savings (KW)	Electric Savings (MBtu/Yr)	Gas Savings (MBtu/Yr)	Oil Savings (MBtu/Yr)	Coal Savings (MBtu/Yr)	Total Savings (MBtu/Yr)	Water Savings (KGals/Yr)
Electrical							
High Eff Motors (Large)	18	280	0	0	0	280	0
High Eff Motors (Medium)	13	203	0	0	0	203	0
High Eff Motors (Small)	46	742	0	0	0	742	0
Ventln Motor ASD (Large)	0	93	0	0	0	93	0
Ventln Motor ASD (Medium)	0	52	0	0	0	52	0
Ventln Motor ASD (Small)	0	0	0	0	0	0	0
Envelope							
6.5 Inch Addtnl Clg Insul	0	95	0	1922	0	2017	0
Ext Insul Finish Sys	0	0	0	0	0	0	0
FH 6.0 Inch Addtnl Clg Insul	0	0	0	0	0	0	0
FH Rockwool Wall Insulation	0	0	0	0	0	0	0
High Reflctnce Roof Membrn	0	0	0	0	0	0	0
Radiant Barriers	0	0	0	0	0	0	0
Shading Devices	0	0	0	0	0	0	0
Storm Windows	0	0	0	0	0	0	0
Window Film	0	42	0	1145	0	1187	0
Heating/Cooling							
Enthalpy Recvry Desscnt Wheel	0	0	0	0	0	0	0
Evap. Pre-Cool Air	0	0	0	0	0	0	0
FH Desuperheaters	11	579	0	0	0	579	0
FH Duct Seals	0	136	0	0	0	136	0
FH Flame Ret. Burners	0	0	0	0	0	0	0
FH Gas Engine Drvn HP	0	0	0	0	0	0	0
FH Ground Source HP	0	0	0	0	0	0	0
FH Heat Pumps	0	0	0	0	0	0	0
FH HiEff Gas Furn	0	0	0	0	0	0	0
FH HiEff Oil Furn	0	0	0	3757	0	3757	0
FH High SEER AC	0	0	0	0	0	0	0
FH Insulate Ducts	0	27	0	538	0	565	0
FH Nom Eff Gas Furn	0	0	0	0	0	0	0
FH Progrmmbl Thermostats	0	0	0	707	0	707	0
FH Whole House Fans w/AC	0	0	0	0	0	0	0
Flame Retention Burners	0	0	0	874	0	874	0
Gas Hieff Boilers	0	0	0	0	0	0	0
Gas Nomeff Boiler	0	0	0	0	0	0	0
Oil Nomeff Boiler	0	0	0	1188	0	1188	0
SLDC Panels	0	1270	0	11454	0	12724	0
Ventilation Heat Recovery	2	24	0	3914	0	3938	0
Lighting							
4' Fluorescent Ltng	984	12225	0	-2780	0	9445	0

REEP RESOURCE SUMMARY REPORT

10/27/94

ECO Type / ECO	Demand Savings (KW)	Electric Savings (MBtu/Yr)	Gas Savings (MBtu/Yr)	Oil Savings (MBtu/Yr)	Coal Savings (MBtu/Yr)	Total Savings (MBtu/Yr)	Water Savings (KGals/Yr)
Compact Fluorescent Ltng	186	1654	0	-375	0	1279	0
Constant Level Lighting	0	0	0	0	0	0	0
Exit Lighting	18	543	0	-123	0	420	0
High Pressure Sodium Lghts	58	515	0	0	0	515	0
High wattage incand replcmnt	507	4498	0	-1023	0	3475	0
Occupancy Sensor	0	886	0	-115	0	771	0
Miscellaneous							
Efficient Computers	0	0	0	0	0	0	0
High Eff Refrig Replcmnt	0	0	0	0	0	0	0
Renewables							
Barracks Solar Water Htg	0	0	0	0	0	0	0
FH Passive Solar Sunspace	0	0	0	0	0	0	0
FH Solar Water Htg	0	0	0	0	0	0	0
Microclimate Modifications	0	0	0	0	0	0	0
Photovoltaic Peaking Station	0	0	0	0	0	0	0
Solar Street Lighting	0	0	0	0	0	0	0
SolarWall for Maint Bldgs	0	0	0	2928	0	2928	0
Wind Energy	0	0	0	0	0	0	0
Utilities							
Amorphs Core Transfrmrs	0	0	0	0	0	0	0
DF NG Chllrs 5-50 Tons	0	0	0	0	0	0	0
DF NG Chllrs 50-100 Tons	0	0	0	0	0	0	0
DF NG Chllrs >100 Tons	0	0	0	0	0	0	0
EMCS	0	0	0	0	0	0	0
GasEng Chllrs 5-50 Tons	0	0	0	0	0	0	0
GasEng Chllrs 50-100 Tons	0	0	0	0	0	0	0
GasEng Chllrs >100 Tons	0	0	0	0	0	0	0
HiEff Chllrs 5-50 Tons	0	0	0	0	0	0	0
HiEff Chllrs 50-100 Tons	0	0	0	0	0	0	0
HiEff Chllrs >100 Tons	0	0	0	0	0	0	0
Manhl Sump-Pmp I/R Prgrm	0	0	0	0	0	0	0
Storage Cooling Systems	0	0	0	0	0	0	0
Undrgrnd Heat Dist Sys Rprs	0	0	0	0	0	0	0
Water							
FH Hot Water Heat Pump	0	0	0	0	0	0	0
FH Low Flow Toilets	0	0	0	0	0	0	0
FH Tankless Water Heaters	0	0	0	0	0	0	0
FH Ultra Low Flow Toilets	0	0	0	0	0	0	7015
Faucet Aerators	0	104	0	0	0	104	340
Flush Valve Retrofits	0	0	0	0	0	0	3881
Horizntl Axis Washng Mchns	0	0	0	0	0	0	0

REEP RESOURCE SUMMARY REPORT

10/27/94

ECO Type ECO	Demand Savings (KW)	Electric Savings (MBtu/Yr)	Gas Savings (MBtu/Yr)	Oil Savings (MBtu/Yr)	Coal Savings (MBtu/Yr)	Total Savings (MBtu/Yr)	Water Savings (KGals/Yr)
Low-flow Shower Head	0	322	0	0	0	322	900
Water Consrvng Dishwshrs	0	0	0	0	0	0	0
Water Distibtn Leak Repair	0	0	0	0	0	0	8251
Wtr Htr Insulation Blanket	0	264	0	0	0	264	0
Totals	1843	24554	0	24011	0	48565	20387

REEP POLLUTION SUMMARY REPORT

10/27/94

ECO Type ECO	SOx (Tons/Yr)	NOx (Tons/Yr)	Part (Tons/Yr)	CO (Tons/Yr)	CO2 (Tons/Yr)	HC (Tons/Yr)	CFC (Lbs/Yr)
Electrical							
High Eff Motors (Large)	0.74	0.21	0.03	0.01	61.75	0.00	0.00
High Eff Motors (Medium)	0.54	0.16	0.02	0.01	44.77	0.00	0.00
High Eff Motors (Small)	1.97	0.57	0.08	0.02	163.63	0.00	0.00
Ventln Motor ASD (Large)	0.25	0.07	0.01	0.00	20.51	0.00	0.00
Ventln Motor ASD (Medium)	0.14	0.04	0.01	0.00	11.47	0.00	0.00
Ventln Motor ASD (Small)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Envelope							
6.5 Inch Addtnl Clg Insul	0.91	0.27	0.04	0.04	184.32	0.00	0.00
Ext Insul Finish Sys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH 6.0 Inch Addtnl Clg Insul	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Rockwool Wall Insulation	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High Reflctnce Roof Membrn	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Radiant Barriers	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shading Devices	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Storm Windows	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Window Film	0.50	0.15	0.02	0.02	106.59	0.00	0.00
Heating/Cooling							
Enthalpy Recvry Desscnt Wheel	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Evap. Pre-Cool Air	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Desuperheaters	1.53	0.44	0.06	0.02	127.68	0.00	0.00
FH Duct Seals	0.36	0.10	0.01	0.00	29.99	0.00	0.00
FH Flame Ret. Burners	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Gas Engine Drvn HP	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Ground Source HP	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Heat Pumps	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH HiEff Gas Furn	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH HiEff Oil Furn	1.29	0.38	0.06	0.07	319.35	0.00	0.00
FH High SEER AC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Insulate Ducts	0.26	0.07	0.01	0.01	51.68	0.00	0.00
FH Nom Eff Gas Furn	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Progrmmbl Thermostats	0.24	0.07	0.01	0.01	60.10	0.00	0.00
FH Whole House Fans w/AC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flame Retention Burners	0.30	0.09	0.01	0.02	74.29	0.00	0.00
Gas Hieff Boilers	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas Nomeff Boiler	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oil Nomeff Boiler	0.41	0.12	0.02	0.02	100.98	0.00	0.00
SLDC Panels	7.30	2.13	0.33	0.24	1253.66	0.02	0.00
Ventilation Heat Recovery	1.41	0.41	0.07	0.07	337.98	0.01	0.00
Lighting							
4' Fluorescent Ltng	31.44	9.07	1.30	0.32	2459.62	0.06	0.00
Compact Fluorescent Ltng	4.25	1.23	0.18	0.04	332.87	0.01	0.00

REEP POLLUTION SUMMARY REPORT

10/27/94

ECO Type ECO	SOx (Tons/Yr)	NOx (Tons/Yr)	Part (Tons/Yr)	CO (Tons/Yr)	CO2 (Tons/Yr)	HC (Tons/Yr)	CFC (Lbs/Yr)
Constant Level Lighting	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exit Lighting	1.40	0.40	0.06	0.01	109.29	0.00	0.00
High Pressure Sodium Lghts	1.36	0.39	0.06	0.02	113.57	0.00	0.00
High wattage incand replcmnt	11.57	3.34	0.48	0.12	904.97	0.02	0.00
Occupancy Sensor	2.31	0.67	0.10	0.02	185.61	0.00	0.00
Miscellaneous							
Efficient Computers	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High Eff Refrig Replcmnt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewables							
Barracks Solar Water Htg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Passive Solar Sunspace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Solar Water Htg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Microclimate Modifications	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Photovoltaic Peaking Station	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solar Street Lighting	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SolarWall for Maint Bldgs	1.00	0.30	0.05	0.05	248.88	0.00	0.00
Wind Energy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Utilities							
Amorphs Core Transfrmrs	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DF NG Chllrs 5-50 Tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DF NG Chllrs 50-100 Tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DF NG Chllrs >100 Tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMCS	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GasEng Chllrs 5-50 Tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GasEng Chllrs 50-100 Tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GasEng Chllrs >100 Tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HiEff Chllrs 5-50 Tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HiEff Chllrs 50-100 Tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HiEff Chllrs >100 Tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manhl Sump-Pmp I/R Prgrm	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Storage Cooling Systems	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Undrgrnd Heat Dist Sys Rprs	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water							
FH Hot Water Heat Pump	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Low Flow Toilets	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Tankless Water Heaters	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FH Ultra Low Flow Toilets	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Faucet Aerators	0.28	0.08	0.01	0.00	22.93	0.00	0.00
Flush Valve Retrofits	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horizntl Axis Washng Mchns	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Low-flow Shower Head	0.85	0.25	0.04	0.01	71.01	0.00	0.00
Water Consrvng Dishwshrs	0.00	0.00	0.00	0.00	0.00	0.00	0.00

REEP POLLUTION SUMMARY REPORT

10/27/94

ECO Type ECO	SOx (Tons/Yr)	NOx (Tons/Yr)	Part (Tons/Yr)	CO (Tons/Yr)	CO2 (Tons/Yr)	HC (Tons/Yr)	CFC (Lbs/Yr)
Water Distibtn Leak Repair	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wtr Htr Insulation Blanket	0.70	0.20	0.03	0.01	58.22	0.00	0.00
Totals	73.31	21.21	3.10	1.16	7455.72	0.12	0.00

Appendix G: Previously Selected Alternative

This Appendix provides more details on Alternative 4A, the selected alternative, which consists of two new 75,000 lb/hr and one new 20,000 lb/hr gas/oil boilers, one new 9,000 lb/hr waste wood boiler with associated processing facility and renovation or replacement of the existing plant equipment (Figures G1 and G2).

Description of Alternative

Boiler 1 would be a 20,000 lb/hr firetube boiler, factory fabricated, and shipped as a complete unit ready for installation. Boilers 2 and 3 would be 75,000 lb/hr packaged type, factory fabricated and assembled, watertube boilers generating saturated steam. The design pressure rating would be 150 psig and the boilers would operate at 120 psig. The burners would be arranged to fire natural gas or No. 2 fuel oil. The fuel oil would be a standby fuel used only if the gas supply were interrupted. The new burners would be low NOx burners. Economizers would be provided for the 75,000 lb/hr boilers. The efficiency for Boilers 2 and 3 would be 82 percent when firing natural gas and 85 percent when firing fuel oil. The existing fuel oil system would be used to handle the No. 2 fuel oil.

The plant operating pressure would remain at 120 psig. The boiler sizes used would allow the plant to meet the peak load of 95,000 lb/hr with the largest boiler out of service and would allow the plant to turndown to the low steaming rates that it can now achieve.

Boiler 4 would be a 9,000 lb/hr waste wood fired boiler with modular construction. The boiler would be rated to burn 1,600 lb/hr waste. This rate was selected to burn the waste wood and waste cardboard generated by the facility. The cardboard is currently sold, but may be burned in the future. The components would be factory fabricated and field assembled. The furnace would be watertube type construction and the convection section would be the firetube type. The flue gas passes from the primary furnace to the convection section, the economizer, the fabric filter baghouse, the induced draft fan, and out the stack. The unit priced for this study is an incinerator style unit and is fairly complex. Simpler boilers may be found that will burn the waste wood and cardboard when the final design is prepared.

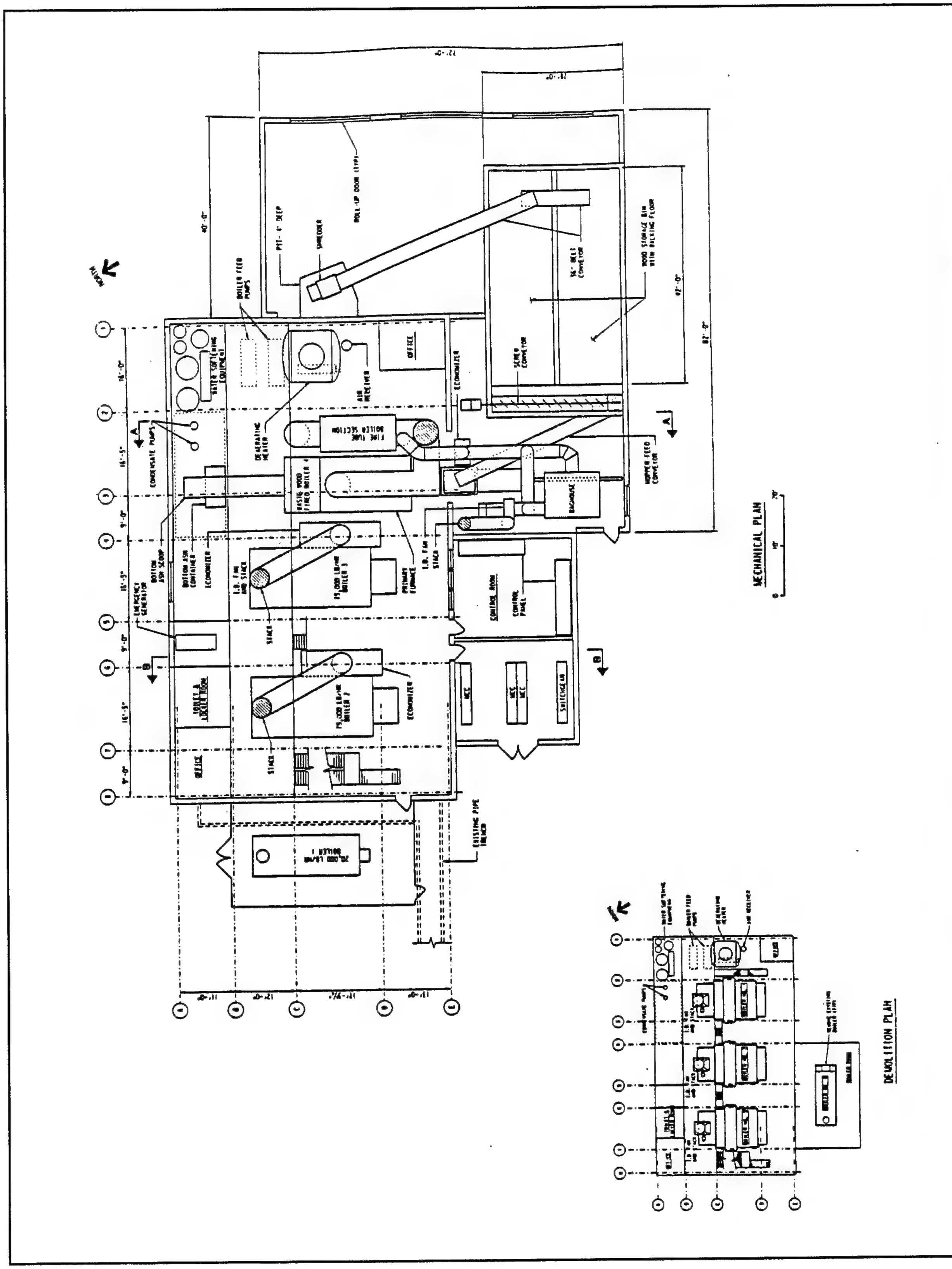


Figure G1. Demolition Plan and Alternate 4: New gas/oil boilers and waste wood boiler.

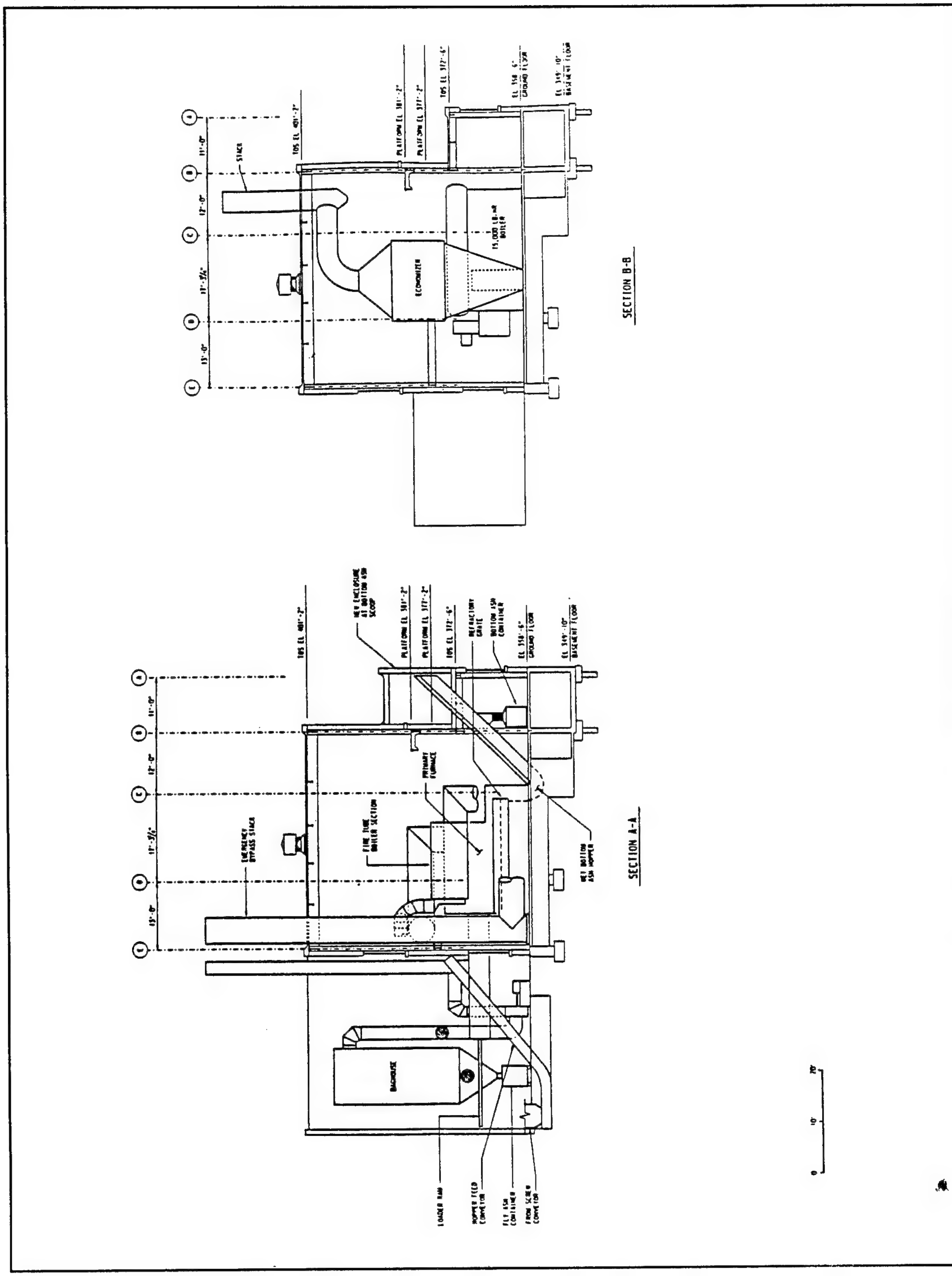


Figure G2. Alternate 4: New gas/oil boilers and waste wood boiler elevation.

Ash from the grates is discharged to a wet ash pit. An automated ash scoop would remove the ash from the pit and discharge it into a roll off container for disposal. The ash from the baghouse would also be discharged into a roll off container for disposal.

The waste wood handling system would consist of approximately 10, 30 cu yd roll-off containers, a truck to handle the containers, and a building to house a dumping area for the containers and the processing equipment. The waste wood will be loaded into the processing equipment with a small skid-steer loader. The wood will pass first through a shredder. The shredder is a low speed machine with two shafts of intermeshing, counter-rotating circular knives that cut the waste wood into pieces with a top size of 8 to 10 in. The shredder will have a ram to force the material into the knives. The shredder will be sized to process 10,000 lb/hr so the waste wood for one week could be processed during a 4-day work week. The waste processing system would not be operated on week ends.

Two 36-in. wide belt conveyors will move the material from the shredder to the storage bins. Two storage bins will be provided to allow maintenance of one of the bins while to other is in operation. The bins are sized to store approximately 35 tons each. This storage capacity will allow the boiler to operate at the design capacity over a 3-day weekend. The bins will discharge at a rate of 10,000 lb/hr. The bins will be constructed with walking floors to move the material to the discharge end. The material will be discharged into a screw conveyor and then a chain conveyor that will move the material to the boiler feed hopper.

The boiler feed pumps, deaerator, and treated water pumps would be replaced. The treated water storage tank would be repaired to fix the small leaks in the concrete wall. An air compressor and receiver would be installed to increase the system capacity as required for the waste wood boiler and baghouse. The condensate pumps and receiver would be replaced and general piping and valve replacement would be done as required. The fuel oil pumps, emergency generator, and sump pump would be replaced. The building lights, windows, and doors would be replaced as required to bring the facility to a near new condition.

New motor control centers and switchgear would be installed in a new electrical room constructed in the former Boiler 4 room. New control panels would be furnished for the new boilers. The panels would be located in a new control room constructed in the former Boiler 4 room. The control system would be made up of single loop electronic controllers or could be handled in a microprocessor-based distributed control system at the option of the user.

Description of Operation

The operation of the gas/oil boilers would be similar to the operation of the existing boilers. No. 2 fuel oil would be used instead of No. 6 oil and would normally be used only as a standby fuel to the natural gas.

The operation of the waste wood boiler would be automated as much as possible. The collection and processing of the waste wood materials would be a manual operation. The wood is transported to the plant in roll-off containers. One operator will drive a truck that will pick up the containers one at a time and take them to the plant where they are dumped. An second operator, using the loader, would pick up the material and load it into the shredder to reduce the pallets to a top particle size of 8 to 10 in. The shredded material would discharge onto a belt conveyor and move to a storage bin. The bin floor would be a walking floor that would feed the material out of the bin, onto conveyors, and then to the boiler feed hopper. The collection and processing of the waste wood material will be accomplished during a 40-hour work week.

The waste wood boiler will be operated continuously except for anticipated down time of 2 days per month for routine maintenance and 2 weeks per year for annual maintenance work. The boiler feed hopper ram will load material into the boiler to maintain a constant steam output. The ash is removed from the boiler and baghouse at regular intervals. The ash will be loaded into small roll off containers for disposal. The boiler will be operated at the load required to burn the waste at the weekly waste generation rate. The existing steam plant boiler operators will be responsible for the boiler operation.

The waste wood boiler steam production could be used to keep the distribution system hot in the summer months and to heat some domestic water. Excess steam generated in the summer months would be vented. The heat loss in the distribution system and the small domestic water heating loads should eliminate the necessity of venting of steam. The boiler steam production during the heating season would replace steam generated by the gas/oil boilers. The steam production for this boiler will range from 6,500 to 7,000 lb/hr for the waste wood generation rate of 10,000,000 lb/yr.

Description of Costs

The operating costs used in the calculations reflect the current operating costs and adjustments that have been made for the modifications planned. The cost for electricity is based on annual consumption of 48.1 million kWh for an annual cost of $2,835,000. The cost for natural gas was based on a heat input of 222,561 million Btu

at a cost of $4.32 per million Btu. The heat input from natural gas was reduced to account for the steam produced by the waste wood boiler.

The maintenance labor cost of $622,631 was used. This cost included the addition of two persons, one to drive the truck to collect the wood waste and one to load the waste into the shredder. The rate of $45,000 per year per person was used for the cost of employment for these two additional people. This rate includes the salary and benefits. The cost of maintenance for the waste wood boiler and wood processing equipment was estimated to be $100,000 per year with half of this cost being labor. The total additional labor cost over and above the existing costs was then $140,000 per year. The maintenance supply cost used was based on the existing costs of $74,076 plus the additional $50,000 discussed above for a total of $124,076.

The service cost is based on the current waste wood disposal cost of $2,250,000 adjusted for the reduced quantity of waste that will require disposal. The service cost used was $194,710 and includes the cost for waste wood disposal for the 2 weeks per year the unit is out of service for annual maintenance and the cost for ash disposal.

Table G1 lists the estimated capital costs for this scheme. Costs of major equipment such as the boilers and the wood handling and processing equipment were obtained from manufacturers. Costs for auxiliary equipment, materials, labor, etc. were developed from data sources and industry references. The costs include the categories of undeveloped design details, engineering, administration, contingency and contractor's overhead, and profit. The cost for replacing other major plant equipment was obtained from the Status Quo program.

Project Schedule

Figure G3 shows the schedule for this project. The schedule shown is based on staged construction so that the required firm boiler capacity is maintained throughout the course of the project. The new Boiler 1 would be installed in a new room constructed on the west side of the existing plant. Boiler 1 would be installed and tested before the existing Boiler 3 is demolished. The firm boiler capacity with the largest boiler out of service with Boiler 3 demolished would then be 20,000 lb/hr for each of the new Boiler 1 and the existing Boiler 4 plus 50,000 lb/hr from either of existing Boilers 1 or 2 for a total of 90,000 lb/hr. This boiler capacity would be able to meet the existing peak load. The new Boiler 2 would be installed, tested, and then the existing Boiler 2 would be demolished. The new Boiler 3 would then be installed and tested. The existing Boiler 1 could then be demolished and Boiler 4 installed.

Table G1. Conceptual cost estimates.

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATE NO. 4A – NEW GAS/OIL BOILERS W/WASTE WOOD BOILER				
	DEMOLITION:				
	BOILER 50,000 #/HR	3	EA	$100,000.00	$300,000
	BOILER 20,000 #/HR	1	EA	$75,000.00	$75,000
	STACKS & FLUES	4	EA	$50,000.00	$200,000
	BUILDING WALL	3000	SF	$10.00	$30,000
	MISCELLANEOUS PIPING, VALVES, HANGERS, ETC.	---	LS	---	$25,000
	MISCELLANEOUS ELECTRICAL WORK	---	LS	---	$10,000
	NEW WORK:				
	BOILER 75,000 #/HR	2	EA	$530,000.00	$1,060,000
	BOILER 20,000 #/HR	1	EA	$117,000.00	$117,000
	GAS LINE TO PLANT	---	LS	---	$4,000,000
	STACKS	3	EA	$10,000.00	$30,000
	BUILDING WALL	3000	SF	$20.00	$60,000
	PIPING, VALVES, HANGERS & INSULATION (FOR BOILERS)	---	LS	---	$100,000
	BOILER CONTROLS & INSTRUMENTS	---	LS	---	$250,000
	PATCH ROOF	---	LS	---	$10,000
	MISCELLANEOUS PIPING, VALVES, ETC.	---	LS	---	$25,000
	WASTE WOOD BOILER	---	LS	---	$2,300,000
	LOADER	1	EA	$30,000.00	$30,000
	SHREDDER	1	EA	$216,000.00	$216,000
	WALKING FLOOR	2	EA	$46,000.00	$92,000
	BELT CONVEYOR 36" X 12'	1	EA	$12,000.00	$12,000
	BELT CONVEYOR 36" X 45'	1	EA	$30,000.00	$30,000
	ROLL-OFF CONTAINERS	10	EA	$4,000.00	$40,000
	TRUCK TO HANDLE ROLL-OFF CONTAINERS	1	EA	$95,000.00	$95,000
	BUILDING ADDITION	3410	SF	$100.00	$341,000
	BUILDING ADDITION NOT HEATED	3330	SF	$60.00	$199,800
	CHAIN CONVEYOR	1	EA	$36,000.00	$36,000
	SCREW CONVEYOR	1	EA	$24,000.00	$24,000
	MISCELLANEOUS PIPING, VALVES, ETC. FOR WASTE WOOD BOILER	---	LS	---	$15,000
	MISCELLANEOUS ELECTRICAL WORK, MCC'S, ETC.	---	LS	---	$50,000
	SUBTOTAL				$9,772,800
	UNDEVELOPED DESIGN DETAILS				$865,920
	OVERHEAD				$995,808
	PROFIT				$663,872
	SUBTOTAL				$12,298,400
	ENGINEERING, ADMINISTRATION & CONTINGENCIES				$2,459,680
	ESCALATION TO 1996				$1,475,808
	TOTAL				$16,233,888
	PROBABLE COST USE				$16,234,000

NOTES:
1) COSTS FOR ASBESTOS REMOVAL ARE NOT INCLUDED
2) COSTS ARE ESCALATED TO 1996

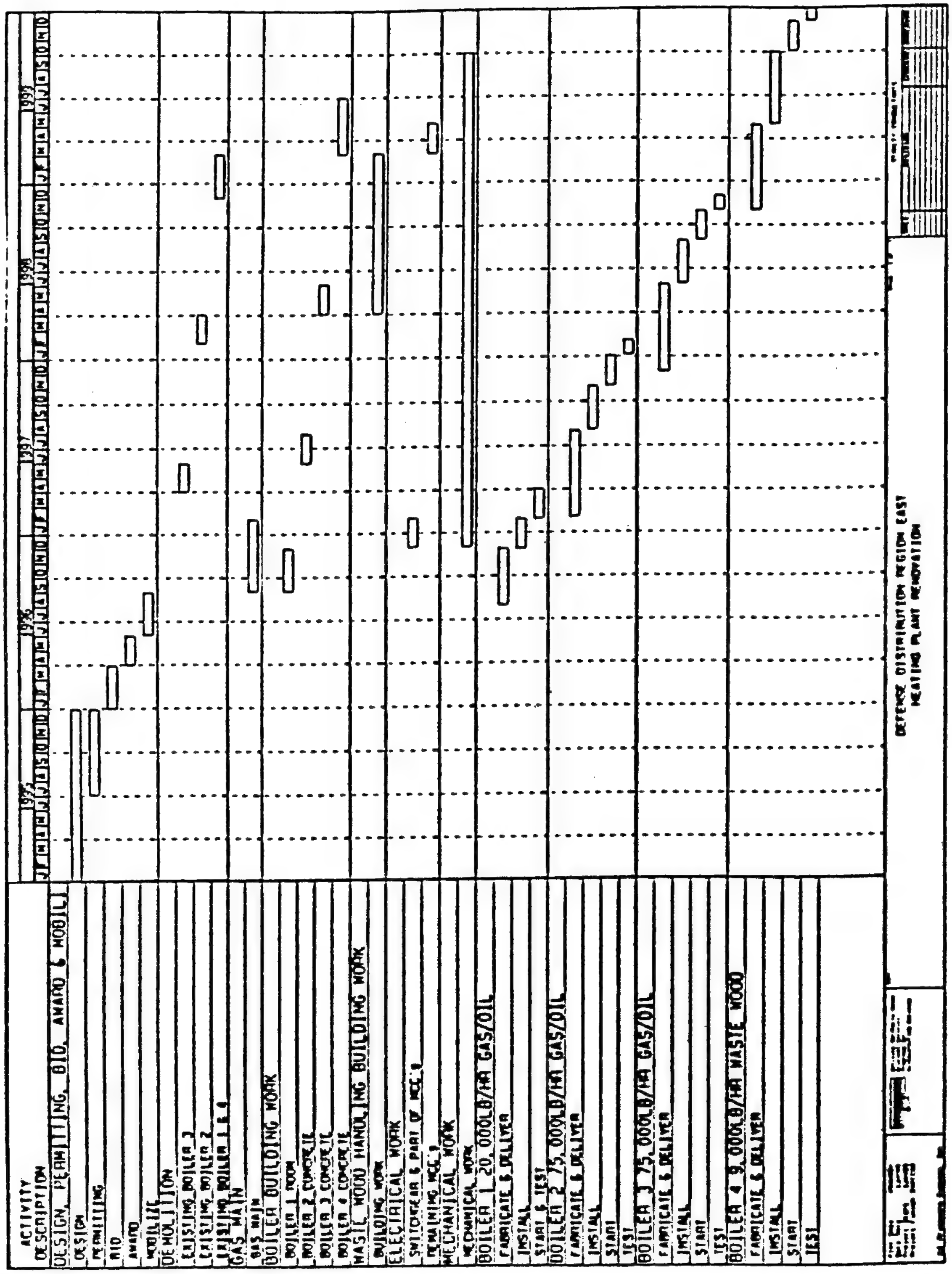


Figure G3. Project schedule.

The south wall and part of the west wall of the new Boiler 1 room would be temporarily installed until the new Boiler 2 was moved into the building through the west wall of the plant between Columns D and E. The new electrical switchgear and some of the motor control centers would be installed in the existing Boiler 4 room with the boiler still in place. This would allow the new equipment to be powered from the new electrical equipment. The remainder of the motor control centers and the electrical room wall would be installed after the removal of the boiler. The boiler control panels for the gas/oil boilers would be installed in the existing Boiler 4 room with the boiler still in-place.

The balance of the plant mechanical and electrical equipment could be installed as plant operations allowed with equipment such as the boiler feed pumps and the deaerator being installed in the summer months when the plant was not operating.

The project schedule allows 3.5 years for construction due to the staging required to keep the plant in operation. The schedule could be shortened if temporary boilers were installed to supply steam to the facility during construction, but this would increase the project cost.

Appendix H: Fuel Properties

MECHANICAL ENGINEERING REFERENCE MANUAL

Ninth Edition

Intended for EXAM USE

RECOMMENDED BY THE
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Michael R. Lindeburg, P.E.

Table 9.4
Selected U.S. Coals

			Proximate Analysis, % (Coal As Received)						Ultimate Analysis, % (Dry, Ash Free)			
No.	State	County	M	VM	FC	A	S	HV (BTU)	C	H_2	O_2	N_2
1	PA	Schuylkill	2.0	1.8	86.2	10.0	0.79	13,070	93.9	2.1	2.3	0.3
2	PA	Lackawanna	2.0	6.3	79.7	12.0	0.60	13,000	93.5	2.6	2.3	0.9
3	VA	Montgomery	3.0	10.5	66.5	20.0	0.61	11,800	90.7	4.2	3.3	1.0
4	WV	McDowell	3.0	16.3	75.7	5.0	0.73	14,420	90.4	4.8	2.7	1.3
5	PA	Westmoreland	3.0	30.3	55.7	11.0	1.80	13,130	85.0	5.4	5.8	1.7
6	KY	Letcher; Pike	3.0	34.4	56.6	6.0	0.72	13,800	85.2	5.4	7.0	1.6
7	OH	Jefferson	6.0	34.8	49.2	10.0	2.44	12,450	82.0	5.5	7.7	1.7
8	IL	Saline; Perry	10.0	31.7	48.3	10.0	1.6	11,610	80.6	5.4	10.3	1.7
9	UT	Carbon; Emery	8.0	36.6	43.4	12.0	0.56	11,480	80.3	5.7	11.7	1.6
10	IA	Polk	13.9	36.9	35.2	14.0	6.15	10,244	75.8	7.7	26.0	1.2
11	CO	Weld; Boulder	24.0	30.2	40.8	5.0	0.36	9,200	75.0	5.1	17.9	1.5
12	WY	Campbell	24.0	30.0	36.0	10.0	0.33	8,450	74.1	5.1	18.7	1.3
13	ND	McLean; Morton	40.0	27.6	23.4	9.0	1.42	6,330	72.4	4.7	18.6	1.5

Table 9.5
Physical and Chemical Properties of Wood

Wood	Density, lbm/ft^3 air dried	Density, lbm/ft^3 green	Gross heating value, BTU/lbm (kiln dried)	Ultimate Analysis, % (dry) C	H_2	O_2	ash
Ash, white	42	47	8,210	49.73	6.93	43.04	0.30
Birch, white	38	51	7,958	49.77	6.49	43.45	0.29
Fir	27	52	8,285	52.32	6.42	41.23	0.03
Oak, black	42	61	7,530	48.78	6.09	44.98	0.15
red	45	65	7,988	49.49	6.62	43.74	0.15
white	48	59	8,112	50.44	6.59	42.73	0.24
Pine, pitch	36	54	10,420	59.00	7.19	32.68	1.12
white	27	39	8,176	52.55	6.08	41.25	0.12
yellow	29	49	8,836	52.60	7.02	40.07	0.31

10 LIQUID FUELS

Liquid fuels commonly are lighter hydrocarbon products refined from crude petroleum oil. They include liquified petroleum gases (LPG), gasoline, kerosene, jet fuel, diesel fuels, and light heating oils. The level of refinement of liquid petroleum fuels determines fuel composition, ignition temperature, flash point, viscosity, and heating value.

Specifications for various grades of fuel oils are based on requirements of different types of burners. Fuel oils are classified as *distillate oils* (lighter petroleum products) and *residual fuel oils* (heavier oils).

- Grade No. 1: A light distillate with high volatility, used in vaporizing type burners; highest in cost/gallon.
- Grade No. 2: A distillate oil heavier in viscosity and API gravity than No. 1, used in pressure atomizing burners; in common use domestically and in medium capacity industrial burners.
- Grade No. 4: Light residual oil or heavy distillate used in burners designed to atomize oils of higher viscosities.
- Grade No. 5L (Light): A residual oil heavier than No. 4; may require preheating for pumping and burning.
- Grade No. 5H (Heavy): A residual oil more viscous than No. 5L requiring preheating.
- Grade No. 6: Also known as *Bunker C oil*; frequently used in industrial applications;

requires preheating for pumping and additional heating for burning; lowest in cost/gallon.

Tables 9.6 and 9.7 list typical properties of fuel oils.

Table 9.6
Properties of Fuel Oils

Grade No.	Weight, lbm/gallon	Heating value BTU/gallon
1	6.675–6.95	132,000–137,000
2	6.960–7.296	137,000–141,000
4	7.396–7.787	143,100–148,000
5L	7.686–7.94	146,800–150,000
5H	7.89–8.08	149,400–152,000
6	8.053–8.488	151,300-155,900

Table 9.7
Fuel Oil Grade vs. Firing Rate

Firing rate, gph	Recommended Grade
up to 25	No. 2
25–35	No. 2, No. 4
35–50	No. 2, No. 4
	No. 5 (Light)
	No. 5 (Heavy)
50-100	No. 5 (Heavy)
	No. 6

Fuel oil burner designs are based on oil atomizing viscosities according to table 9.8.

Table 9.8
Burner Type and Atomizing Viscosity

Burner type	Atomizing viscosity SSU
pressure	30–70
mechanical	35–150
low pressure air atomizing	80–90
steam/high pressure air atomizing	150-250
rotary cup	150–300
sonic	150–300

In handling fuel oils, suction pipes for No. 5 and No. 6 oils should not exceed 100 feet of equivalent length without a booster pump to prevent pump cavitation.

Specifications for various grades of *diesel oil* are based on characteristics similar to those of fuel oils.

- Grade No. 1 Diesel: A distillate oil for high-speed engines in service requiring frequent speed and load changes.
- Grade No. 2 Diesel: A distillate oil of lower volatility for engines in industrial and heavy mobile service.
- Grade No. 4 Diesel: More viscous distillate oils with blends of residual oils for use in medium speed engines under sustained loads.

Property specifications for No. 1, No. 2, and No. 4 diesel and fuel oils are identical except that diesel fuels can be specified by cetane number. *Cetane number* is a measure of the ignition quality of a fuel.

11 GASEOUS FUELS

Various gaseous fuels are used as energy sources, but most applications are limited to natural gas and liquefied petroleum gases. *Natural gas* is a mixture of methane (55 to 95%), higher hydrocarbons (primarily ethane), and noncombustible gases. Typical heating values range from 950 to 1100 BTU/ft^3 at industrial STP (30 inches Hg and 60°F). *Liquefied petroleum gases* are available as butane, propane, and mixtures of the two. At atmospheric pressure, propane boils at −40°F, while butane boils at 32°F.

There are a number of manufactured gases which can be used where available.

- coke-oven gas: Approximately 17% of the coal heated to form coke can be recovered. This gas is largely hydrogen.
- blast furnace gas: The gas discharged from blast furnaces is approximately 55% nitrogen and 20% carbon monoxide.
- water gas: Steam passing through burning coke will produce carbon monoxide and hydrogen gas.
- enriched water gas, carbureted water gas: This is water gas which has been mixed with blast furnace gas, or gas produced from oil cracked by spraying onto hot bricks.
- producer gas: This gas is produced by burning coal in an oxygen deficient atmosphere (as in burning coal seams underground instead of mining the coal). The gas is high in carbon monoxide.

Gas burners can be natural draft or forced draft. *Natural draft* burners rely on chimney draft to draw off combustion gases. A fan is used only to control combustion air. *Forced draft* burners also use the fan to move products through the burner; combustion occurs under pressure.

USACERL DISTRIBUTION

Chief of Engineers
ATTN: CEHEC-IM-LH (2)
ATTN: CEHEC-IM-LP (2)
ATTN: CECC-R
ATTN: CERD-L

Defense Distribution Region East
ATTN: DLA-ASAACE (8)

Defense Tech Info Center 22304
ATTN: DTIC-O (2)

16
8/96